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Potential anti-influenza effective plants used in Turkish folk medicine: A review

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ABSTRACT

Ethnopharmacological relevance: Due to the outbreaks such as SARS, bird flu and swine flu, which we frequently encounter in our century, we need fast solutions with no side effects today more than ever. Due to having vast ethnomedical experience and the richest flora (34% endemic) of Europe and the Middle East, Turkey has a high potential for research on this topic. Plants that locals have been using for centuries for the prevention and treatment of influenza can offer effective alternatives to combat this problem. In this context, 224 herbal taxa belonging to 45 families were identified among the selected 81 studies conducted in the seven regions of Turkey. However, only 35 (15.6%) of them were found to be subjected to worldwide in vitro and in vivo research conducted on anti-influenza activity. Quercetin and chlorogenic acid, the effectiveness of which has been proven many times in this context, have been recorded as the most common (7.1%) active ingredients among the other 56 active substances identified.

Aim of the study: This study has been carried out to reveal the inventory of plant species that have been used in flu treatment for centuries in Turkish folk medicine, which could be used in the treatment of flu or flu-like pandemics, such as COVID 19, that humanity has been suffering with, and also compare them with experimental studies in the literature.

Materials and methods: The investigation was conducted in two stages on the subject above by using electronic databases, such as Web of Science, Scopus, ScienceDirect, ProQuest, Medline, Cochrane Library, EBSCO, HighWire Press, PubMed and Google Scholar. The results of both scans are presented in separate tables, together with their regional comparative analysis.

Results: Data obtained on taxa are presented in a table, including anti-influenza mechanism of actions and the active substances. Rosa canina (58.7%) and Mentha x piperita (22.2%) were identified as the most common plants used in Turkey. Also, Sambucus nigra (11.6%), Olea europaea (9.3%), Eucalyptus spp., Melissa officinalis, and Origanum vulgare (7.0%) emerged as the most investigated taxa.

Conclusion: This is the first nationwide ethnomedical screening work conducted on flu treatment with plants in Turkey. Thirty-nine plants have been confirmed in the recent experimental anti-influenza research, which strongly shows that these plants are a rich pharmacological source. Also, with 189 (84.4%) taxa, detections that have not been investigated yet, they are an essential resource for both national and international pharmacological researchers in terms of new natural medicine searches. Considering that the production of antimalarial drugs and their successful use against COVID-19 has begun, this correlation was actually a positive and remarkable piece of data, since there are 15 plants, including Centaurea drabifolia subsp. Phlocosa (an endemic taxon), that were found to be used in the treatment of both flu and malaria.

1. Introduction

Plants have always been the primary choice for preventing and treating various diseases faced by human beings, and contain specific or broad-spectrum active compounds for almost any type of disease (Alaoui-Jamali, 2010). People living in Turkey have also benefited from plants in the prevention and treatment of various diseases for centuries. People living in rural areas still have an especially rich medicinal plant repertoire (Ertug, 2004). Although herbal cures such as rosehip tea, peppermint-lemon tea and garlic-lemon tea, which are used to prevent and treat flu outbreaks, are well known by the local people, the vast majority of them and their anti-influenza effects have not yet been
In influenza classification, influenza viruses are RNA viruses that comprise 4 of the 7 genera of the family Orthomyxoviridae (Kawaoka, 2006), while Human Rhinoviruses (HRVs) are within the genus Enterovirus and the family Picornaviridae (Jacobs et al., 2013). Nevertheless, the flu caused by influenza viruses and the common cold caused by Human Rhinovirus are very similar, although both are types of respiratory virus in terms of disease symptoms (CDC, 2019). In general, it is the most common cause of respiratory viral disease in spring, summer and autumn, while the flu virus is dominant in winter. On the other hand, flu or flu-like viruses are highly contagious and cause serious complications and outbreaks that erupt with a different genetic code each year and even life-threatening pandemics (Jacobs et al., 2013). Nowadays, COVID-19 is one of the most striking examples of a flu-like virus. Due to its fast transmission through direct contact with infected people and contaminated substances or droplets, thousands of patients are dying every day with a fever, cough, and shortness of breath, and, currently, there is no definitive treatment or vaccine, except for some available malaria medicines (Basiri, 2020). There is an urgent need to identify new naturally occurring antiviral molecules, as resistance to anti-influenza drugs appears to be prevalent to an alarming extent (Haidari et al., 2009). Herbal remedies have been used for centuries to treat flu symptoms, and essential oils derived from them have been prescribed as complementary and alternative treatments against influenza (Setzer, 2016). Therefore, to contribute to the treatment of influenza disease and bearing in mind their greater importance, we focused on plants whose successful anti-influenza effects have been tried and trusted by Turkish people for centuries.

Essentially, some antiviral medicines, such as Oseltamivir and Zanamivir, are available for treatment; however, the emergence of drug-resistant strains as a new type of virus is a serious concern (Watanabe et al., 2000). Nowadays, COVID-19 is one of the most striking examples of a flu-like virus. Due to its fast transmission through direct contact with infected people and contaminated substances or droplets, thousands of patients are dying every day with a fever, cough, and shortness of breath, and, currently, there is no definitive treatment or vaccine, except for some available malaria medicines (Basiri, 2020). There is an urgent need to identify new naturally occurring antiviral molecules, as resistance to anti-influenza drugs appears to be prevalent to an alarming extent (Haidari et al., 2009). Herbal remedies have been used for centuries to treat flu symptoms, and essential oils derived from them have been prescribed as complementary and alternative treatments against influenza (Setzer, 2016). Therefore, to contribute to the treatment of influenza disease and bearing in mind their greater importance, we focused on plants whose successful anti-influenza effects have been tried and trusted by Turkish people for centuries.

Essentially, some antiviral medicines, such as Oseltamivir and Zanamivir, are available for treatment; however, the emergence of drug-resistant strains as a new type of virus is a serious concern (Watanabe and Kawaoka, 2015). In addition, vaccines are only around 50% effective in the elderly, where the highest mortality rates occur (Wang et al., 2006; Rajasekaran et al., 2013), and side effects, such as nausea, vomiting, neuropsychiatric events, abdominal pain, diarrhoea, sinusitis, headache and dizziness, are very common (Grienke et al., 2009). For this reason, natural active ingredients or traditional applications with proven effectiveness are accepted more in the world (Rajasekaran et al., 2013).

Empirical information and bio experiments based on the ethnomedical benefits of plants show that they have the potential to identify new antivirals that can be used against influenza. In particular, the results of research on plant-based antiviral activity and active ingredients against influenza viruses using purified plant chemicals are promising (Grienke et al., 2012). Some of them include determination of the antiviral and cytotoxic effect of quercetin 3-glucoside (Q3G) from Dianthus superbus on influenza virus infection and replication by Nile et al. (2020), revealing the neuraminidase inhibitory effect (on the Influenza Virus replication) of agathisflavone derived from the Anacardium occidentale by De Freitas et al. (2020), and discovering the inhibitory effect of pomegranate (Punica granatum L.) peel extract polyphenol activity, RNA replication, and protein expression of the influenza virus by Moradi et al. (2020).

As Velavan and Meyer (2020) stated, the emergence of the COVID-19 flu-like pandemic with high epidemic and mortality rates in early 2020 shows that there is an urgent need for new, effective and various measures against this viral disease. Turkey has the potential for serious research on this topic due to having a very rich (34% of endemic) flora and folkloric experience in plant utilization that has existed for centuries (Güner et al., 2012). Notwithstanding, local research to date, such as the experimental (in vitro or in vivo) study, not a review.

In this study, the total list of plant taxa used in Turkish folk medicine against diseases caused by influenza viruses is presented for the first time. It also reveals which of these plants are researched worldwide for anti-influenza activity, along with their active compounds. Taxa that do not have a research record are an important resource for new drug researchers.

2. Materials and methods

2.1. Data collection

This research was conducted in two stages. While, in the first stage, a list of herbs that are used for the treatment of flu in Turkish folk medicine is presented, in the second stage, it was investigated whether there are experimental studies of “anti-influenza” effects of the plants from this list in the world literature. Among these studies those with active compound determination were especially preferred. Various electronic databases, such as Web of Science, Scopus, ScienceDirect, ProQuest, Medline, Cochrane Library, EBSCO, HighWire Press, PubMed and Google Scholar, have been scanned for both studies. In the interest of the plant inventory survey, the national studies conducted in all regions (Fig. 1) of Turkey were taken into account. Moreover, to achieve detailed coverage, the database of the Higher Education Council of Turkey National Thesis Center was also included in the research literature. The results of both scans are presented in Tables 3 and 4.

Only English and Turkish words were used in the search engines. If they exist, their English translations were reviewed for the studies conducted in different languages, such as Chinese, Korean and French. In this context, approximately 700 articles conducted between January 1977 and February 2020 throughout Turkey were excluded since they did not meet the inclusion criteria and a consensus has been provided among the 81 works on the determination of medicinal plants used by local people for centuries. The list of selected plants from these studies is presented in Table 1.

2.2. Data selection

The studies determined to be within the scope of plant screening were reviewed, compared and carefully selected according to the following criteria. Accordingly, a study should:

- be carried out in an area within the borders of Turkey.
- performed on ethnobotanical or ethnopharmacological concept layout.
- include scientific names and local names of the plants used.

In addition, the criterion for choosing the book sources was either the writer having an academic title or the work having been cited. If neither of these were in case, the work was not taken into consideration.

The screening of the resulting plants in the world literature was carried out considering the following criteria. Accordingly, a study should be:

- an experimental (in vitro or in vivo) study, not a review.
- included the scientific name of the plant in its title. In case of writing only the English name of the plant, it is obligatory to include the scientific name in the text.
- carried out under the headings of “anti-flu, anti-influenza or antiviral activities against influenza”.

If it contains the active compound(s), it becomes preferable and the mechanism of action is recorded.

2.3. Data arrangement

Table 1 contains the scientific names of plants, their families, local
names, English common names, parts used, forms used, and references. The validation of the scientific names of the specified plant taxa was provided by the book Turkey Plant List (Vascular Plants) (Güner et al., 2012), the International Plant Names Index (IPNI: http://www.ipni.org) and the PlantList (http://www.theplantlist.org). English common names of the taxa are placed in the table using the following databases or search engines: EPPO Global Database (https://gd.eppo.int), Plants Database (http://garden.org/plants), USDA PLANTS (http://plants.sc.egov.usda.gov/java), Encyclopedia of Life (https://eol.org), Lebanon Flora (http://www.lebanon-flora.org), Springer Link (https://link.springer.com/article), Flora of Israel Online (http://flora.org.il), Altervista Flora Italiana (http://luirig.altervista.org/flora), and Plants of the World online (http://www.plantsoftheworldonline.org). Taxa for which common English names could not be found have been noted as endemic to Turkey, or containing Irano-Turanian elements.

Finally, the plants were arranged in alphabetical order according to family names. In order to prove the scientific validity of the ethnobotanical data obtained, the research data of the experimental studies regarding the taxa in the list, as found in the world literature, are shown in a separate table (Table 4). In this table, the mechanism of action, active compounds and used parts are also included, in addition to the researched taxa and their references. Care has been taken to ensure that the findings obtained in these screening studies belong to experimental studies (in vitro or in vivo), not a review.

2.4. Comparative analysis

After obtaining the total list of plants with anti-influenza potential in Turkish folk medicine, a comparison was made to determine the similarity percentages in similar studies conducted in neighboring and nearby countries (Table 2). To avoid distraction from the subject integrity, not all studies in those countries were included in our comparison. Therefore, only the study with the richest content and the highest percentage of similarity from each country was included in the comparison list. Studies with a similarity percentage >10% were eliminated in the primary elections.

3. Results and discussion

The demand for new antimicrobial agents, especially antivirals, is constantly increasing. This demand arises from the lack of antiviral agents in the market and the emergence of resistant mutants to existing drugs (Vijayan et al., 2004). Throughout our existence, human beings have always been in search of healing from plants in the fight against winter diseases, but clinical studies have to this point been limited. Although the following work is relatively new in Turkey, they are promising for future study: Duman et al. (2018) elicited in vitro antiviral activity of Ribes uva-crispa L and Ribes multiflorum Kit ex Schult, which are naturally grown in Turkey, use the methanol and aqueous extracts of the leaves and fruits; Dogan et al. (2020) revealed anti-RSV effects of Ribes uva-crispa juicy fruit and leaf methanol extracts against the respiratory syncytial virus (RSV) (the cause of a worldwide viral infection), and emphasized their advantages to synthetic drugs; finally, Adem et al. (2020) found that natural polyphenols, such as hesperidin, routine, diosmin and apiin were more effective than nelfinavir in treating COVID-19. The plants (Table 3), which have been used by locals in Turkey for centuries for the prevention and treatment of influenza and its adverse effects - from colds to sudden deaths from respiratory failure - need to be investigated in this way. Today, much more research is needed, as outbreaks such as SARS, avian influenza, swine influenza and COVID-19 threaten the existence of human beings every year.

3.1. Regional analysis

Distribution of 91 studies by region was performed as follows: 13 in the Mediterranean (16.0%), 11 in Eastern Anatolia (13.6%), 10 in the Marmara and Aegean region (12.3%), 8 in the Black Sea (12%), 7 in Central and Southeastern Anatolia (11.1%), and 15 general studies across all regions (18.5%). The regional distribution of 921 total citations received was as follows: Mediterranean: 150 (16.3%), Eastern...
Eighty one carefully selected works from ethnomedicinal studies conducted in Turkey.

Table 1

| Selected Studies | Cited Taxa | Citation % | Region          |
|------------------|------------|------------|-----------------|
| Şenkardeş (2014) | 39         | 17.4       | Central Anatolia|
| Tuzlaci (2006)   | 34         | 15.2       | All Regions     |
| Baytop (1999)    | 33         | 14.7       | Central Anatolia|
| Ertuğ et al. (2004) | 29     | 12.9       | Marmara         |
| Özhatay et al. (2009) | 26  | 11.6       | Aegean          |
| Sargin (2015)    | 25         | 11.2       | Mediterranean   |
| Ölgün (2019)     | 23         | 10.3       | Eastern Anatolia|
| Polat et al. (2013) | 23     | 10.3       | Marmara         |
| Gökgöz (2014)    | 22         | 9.8        | All Regions     |
| Kılıç (2019)     | 22         | 9.8        | Southeastern Anatolia|
| Genc (2010)      | 21         | 9.4        | Marmara         |
| Köse (2019)      | 20         | 8.9        | Black sea       |
| Antoluk (2018)   | 19         | 8.5        | Mediterranean   |
| Sargin et al. (2015a) | 19  | 8.5        | Mediterranean   |
| Cakícioğlu et al. (2011) | 18  | 8.0        | Eastern Anatolia|
| Demirci-Kayıran (2019) | 18 | 8.0        | All Regions     |
| İşler (2017)     | 17         | 7.6        | All Regions     |
| Polat (2019)     | 17         | 7.6        | Eastern Anatolia|
| Gürbüz et al. (2019) | 16  | 7.1        | Black sea       |
| Kalaşçılar ve Kalaşçılar (2010) | 16  | 7.1        | All Regions     |
| Bulut and Tuzlaci (2015) | 15  | 6.7        | Marmara         |
| Bulut et al. (2019) | 15  | 6.7        | Mediterranean   |
| Güneş (2017)     | 15         | 6.7        | Marmara         |
| Gündobatan et al. (2016) | 14  | 6.3        | Central Anatolia|
| Çığ (2019)       | 13         | 5.8        | Aegean          |
| Karakoce and Karakoce (2017) | 13  | 5.8        | Black sea       |
| Öztürk et al. (2017)a | 13  | 5.8        | Southeastern Anatolia|
| Sargin and Büyükçengiz (2019) | 13  | 5.8        | Mediterranean   |
| Tuzlaci and Dogan (2010) | 13  | 5.8        | Eastern Anatolia|
| Tuzlaci and Erol (1999) | 13  | 5.8        | Mediterranean   |
| Erzug (2004)     | 11         | 4.9        | Aegean          |
| Güneş and Özhatay (2011) | 11  | 4.9        | Eastern Anatolia|
| Kılıç (2016)     | 11         | 4.9        | Eastern Anatolia|
| Kılıç and sıcak (2013) | 11  | 4.9        | Eastern Anatolia|
| Gürsoy and Guzeleme (2018) | 10  | 4.5        | Mediterranean   |
| Öztürk et al. (2017b) | 10  | 4.5        | Mediterranean   |
| Sarar (2005)     | 10         | 4.5        | Marmara         |
| Tiet et al. (2013) | 10  | 4.5        | Eastern Anatolia|
| Yeşilyurt et al. (2017b) | 10  | 4.5        | Marmara         |
| Akbul et al. (2016) | 9   | 4.0        | Central Anatolia|
| Bulut et al. (2017a) | 9   | 4.0        | Marmara         |
| Cansaran and Kay (2010) | 9     | 4.0       | Black sea       |
| Güneş and Selvi (2016) | 9  | 4.0        | Marmara         |
| Nacacuk and Dukun (2015) | 9   | 4.0       | Black sea       |
| Özçelik and Orhan (2016) | 9  | 4.0        | Mediterranean   |
| Akan and Bakur-Sade (2015) | 8   | 3.6        | Central Anatolia|
| Akbul et al. (2019) | 8   | 3.6        | Aegean          |
| Kurt and Karağil (2018) | 8   | 3.6        | Black sea       |
| Polat et al. (2016) | 8   | 3.6        | Central Anatolia|
| Sargin et al. (2013) | 8     | 3.6      | Aegean          |
| Yilmaz (2019)    | 7          | 3.6        | Aegean          |
| Demirci and Özhatay (2012) | 7  | 3.1        | Southeastern Anatolia|
| Kavak et al. (2014) | 7  | 3.1        | Eastern Anatolia|
| Kocaba and Gedik (2016) | 7  | 3.1        | Marmara         |
| Maranki and Maranki (2016) | 7   | 3.1       | All Regions     |
| Tuzlaci and Erzyar-Aymaz (2001) | 7  | 3.1       | Aegean          |
| Ugulu et al. (2009) | 7   | 3.1        | Aegean          |
| Tanker et al. (1998) | 7   | 3.1        | All Regions     |
| Dalar et al. (2018) | 6   | 2.7        | Aegean          |
| Güneş et al. (2018) | 6   | 2.7        | All Regions     |
| Kocaba et al. (2017) | 6   | 2.7        | Mediterranean   |
| Balcı and Balcı (2016) | 5  | 2.2        | Central Anatolia|
| Bulut and Tuzlaci (2013) | 5   | 2.2       | Aegean          |
| Bulut et al. (2017b) | 5   | 2.2        | Aegean          |
| Kociyigil and Özhatay (2006) | 5  | 2.2       | Marmara         |

Anatolia: 141 (15.3%), Aegean: 109 (11.8%), Marmara: 98 (10.6%), Central and Southeastern Anatolia: 82 (8.9%), Black Sea: 75 (8.1%), and general studies covering all regions: 184 (20.0%). The reason why the studies conducted in the Mediterranean and Eastern Anatolia regions were highly cited may be due to the fact that there are more plant options, which is the result of having a higher rate of biodiversity and endemism in these regions (Güneş et al., 2012) compared to others, that the locals can use in the treatment of influenza. In addition, the topographic structure of the region, and the fact that the region is isolated from city centers in winter conditions (Dogánay and Orhan, 2016) may have been a factor for the people living in these rural areas to choose mostly natural treatment methods.

3.2. Data analysis of ethnomedicinal plants used in flu treatment in Turkey

It has been determined that 224 plants, selected from 81 studies composing of 57 articles, 13 books, seven theses, three chapters and one congress report in total, belonging to 43 families. These plant taxa most commonly belong to the Lamiaceae (88 taxa, 39.3%), Compositae (32 taxa, 14.3%), Rosaceae (21 taxa, 9.4%), Malvaceae (13 taxa, 5.8%), and other families (70 taxa, 31.3%). The most preferred outcome of the Lamiaceae family may be due to the Turkish people’s preference for flu treatment, as it is the family that contains the highest dosage of essential oils (Askun et al., 2012). The second family, Compositae, is known as Turkey’s most common family (Güneş et al., 2012). Infusions prepared from taxa with capitula flower structures such as its representative Chamomile are widely used by local people. Therefore, this was an expected result.

According to studies conducted in different regions of Turkey (Fig. 1), the most common genera are Sideritis (16 taxa, 7.1%), Salvia (12 taxa, 5.4%), Thymus (12 taxa, 5.4%), and Origanum (10 taxa, 4.5%). This finding may indicate that these genus members are more effective in anti-influenza treatment than other genera. In addition, they are the most favored medicinal tea for the locals of Turkey, and even without natural nationwide distribution, it is possible to find these products in almost every public market, herbal and spice shop (Ertuğ, 2004; Dogan, 2012). Some species, such as thyme (Thymus spp.), melissa (Melissa officinalis), lavender (Lavandula angustifolia), cassidyon (Lavandula stoechas) and sage (Salvia officinalis), are today being grown in home gardens, balconies or on small farms by rural people for folk medicine use, or for trade and household income (Güneş, 2017; Eki et al., 2020).
were cultivated (1.3%). These parameters are shown in a column in Table 5; wild taxa as “W”, cultivated “C”, cultivated & wild “CW” and endemic “E”. Most of the plant pieces used are aerial parts (41.1%), flowers/flowering branches/petals (30.8%), leaves (25.0%), fruits (17.4%), seeds/cones (8.5%), roots/bulbs/tubers (6.7%), and other parts (stems, buds, barks, whole parts, resins, tar, cupula, bracts, fruit stalks, essential oils and fixed oils) (14.3%). Those parts were mostly used as infusions (78.6%), decoction/boiling (19.2%), raw eating/swallowing/salad (12.9%), molasses/jam/syrup/ juice (7.6%), lotion/drop/cataplasm/vapor compression (6.3%) and other consumption types (roasting, mouthwash, tincture, mixture and pastes) (5.4%) and powdered for spice use (3.1%). The taxa having with the most usage types are Citrus spp (7 types, 3.1%), Rosa canina and Rubus sanctus (5 types, 2.2%) and Viitis vinifera (4 types, 1.8%), while the taxa with the maximum number of consumption parts belong to Rosa canina and Tilia tomentosa (6 parts, 2.7%), and Juniperus oxycedrus (5 parts, 2.2%). Additionally, Rosa canina (with 5 different types of use and 6 different parts) have appeared as the most efficient plants in terms of the total of both part and usage type (Table 3).

3.3. Comparative evaluation of the data with studies of nearby countries

16 taxa, such as Rosa canina (with 46 references and 56.8%) and Mentha x piperita (with 17 references and 21.0%) (Fig. 2, red color), have been identified as the most frequently cited plants. The reason why these herbs are highly cited may be a reflection of their stronger protective and therapeutic effects against flu; this may be the result of the experience gained in Turkish folk medicine for centuries. We would obviously see this when comparing similar studies between 17 geographically close countries (Fig. 2, blue color). The emergence of the data presented in Table 2 in a similar manner as in Fig. 2 confirms the superior efficacy of these plants, with 76.7% similarity.

As a matter of fact, similar results were obtained from studies conducted in 17 neighboring countries, comparing with the taxon list presented in the study, including especially Rosa canina (11 countries with 64.7%), Sambucus nigra (8 countries with 47.1%) and Mentha x piperita (6 countries with 35.3%). While the similarity was seen mostly in Iraq (75.0%), Bosnia and Herzegovina (73.3%), and Cyprus (73.1%), the least similarity was seen in Montenegro (31.8%) and Israel (38.1%). This may due to the fact that, besides the resemblance of landforms, climate and vegetation, we lived together with the cultures of those countries during the Ottoman period for about 500 years. The reason for the low similarity in Israel and Montenegro may be due to the geographical distance as well as the difference of social-cultural habits, religious rituals, topography and flora (Table 2). It was not very surprising that Matricaria chamomilla emerged as the plant used most in influenza treatment in 12 countries (70.6%) since the spreading area of this plant is very wide and it is very easy for the public to access and use (Fig. 2).

3.4. Comparative analysis with studies in the global literature

Experimental research studies carried out in the world in terms of anti-influenza activities have been determined only for 35 out of 224 taxa (15.6%). Still, among these studies, the active substances were detected for only 18 taxa (8.0%); for the remaining 17 taxa (7.6%), it was observed that they had not been specified (Table 4). In Table 4, only “the parts used in research” were given as an idea for these taxa for which active gradients had been “not specified”. It is noteworthy that no investigation has been conducted for 189 (84.4%) taxa yet (they are highlighted in bold in Table 3). Among these 35 taxa, the most common active chemicals are quercetin and chlorogenic acid (7.1%), mentoñin (5.4%) and 1,8-cineole (3.6%). The most preferred mechanisms in research are inhibition of viral replication by inhibiting viral nucleoprotein synthesis or polymerase and neuraminidase activity (40.4% out of the 47 mechanisms in total), blocking the receptor site of the viruses by inhibition of neuraminidase, reducing the hemagglutination, or blocking hemadsorption (31.9%), inhibition of the virus-induced cytopathic effect by blocking hemadsorption (21.3%), and stimulating and boosting of the immunity (6.4%). The reason that the six taxa at the end of the list are shown as a line separated from the alphabetical sequence is that there was no significant result for virus inactivation in the experimental studies conducted for them (Table 4).

According to screening results found in the global literature, the most preferred plants in experimental anti-influenza studies are Sambucus nigra (14.3%, out of 35 taxa), Olearia europa (11.4%), followed by Eucalyptus camaldulensis, E. globules, Melissa officinalis and Origanum vulgare (8.6%). The reason for this may be that these plants are easily accessible in nature or from the virtual market environment, and can be obtained for less money. Additionally, eucalyptus trees in Turkey are also known as “malaria trees”, as the infusion prepared from its leaves is used against malaria in traditional medicine (Baytop, 1999; Ertug, 2004). Although its effectiveness against COVID-19 has not been fully proven by clinical trials, the widespread use and mass production of chloroquine and similar malaria drugs are permitted in many countries, and positive results continue to be achieved (Millan-Onate et al., 2020; Touriet and de Lamballerie, 2020). This correlation of data has been positive and unexpected because there are fourteen more plants, including Centaurea drabifolia subsp. floccosa (an endemic taxon), which have been detected in this study to be used in the treatment of malaria. These fifteen plants are presented in Table 3 by adding the “*” sign to the end of their scientific names.

The percentage of compatibility of the plant parts belonging to these

Table 2

Similarity percentages of neighboring studies (sorted by descending order according to the similarity index).

| Countries          | Regions                  | Total taxa used for influenza | Similar Taxa # | Similarity % | References          |
|--------------------|--------------------------|------------------------------|----------------|--------------|---------------------|
| Iraq               | Sulaymaniyah (Northern)  | 20                           | 15             | 75.0         | Ahmed (2016)        |
| Bosnia and Herzegovina | Javor Mountain          | 15                           | 11             | 73.3         | Savi et al. (2019)  |
| Cyprus             | All                      | 26                           | 19             | 73.1         | Karouou and Deimentzoglou (2011) |
| Bulgaria           | All                      | 18                           | 13             | 72.2         | Koszharova et al. (2013) |
| Romania            | Dobruja (South-Eastern)  | 24                           | 17             | 70.8         | Pieroni et al. (2014) |
| Kosovo             | Southern                 | 20                           | 14             | 70.0         | Mustafi et al. (2015) |
| Croatia            | Knin                     | 18                           | 12             | 66.7         | Varga et al. (2019) |
| Georgia            | Caucasus                 | 20                           | 13             | 65.0         | Busmann et al. (2016) |
| Syria              | Aleppo                  | 14                           | 9              | 64.3         | Alachkar et al. (2011) |
| Iran               | Sijan in Kerman          | 14                           | 9              | 64.3         | Nashed and Khashayar (2014) |
| Albania            | Alps                     | 30                           | 18             | 60.0         | Mustafi et al. (2012) |
| Greece             | Thessaloniki (Northern)  | 74                           | 44             | 59.5         | Hanlidou et al. (2004) |
| Serbia             | South-eastern            | 36                           | 20             | 55.6         | Jarić et al. (2015) |
| Macedonia          | Sharr Mountains          | 20                           | 9              | 45.0         | Rekep et al. (2013) |
| Jordan             | Northern Badia           | 14                           | 6              | 42.9         | Alzweiri et al. (2011) |
| Israel             | All                      | 21                           | 6              | 38.1         | Lev and Amir (2000) |
| Montenegro         | Prokletije Mountains     | 22                           | 7              | 31.8         | Menković et al. (2011) |
Table 3
The list of plant taxa used against influenza in Turkish folk medicine.

| Families       | Sc. names          | W/C/E | English names            | Parts                        | Preparations                          | References |
|----------------|--------------------|-------|--------------------------|------------------------------|---------------------------------------|------------|
| Adoxaceae      | Sambucus ebulus L. | W     | European dwarf elder    | Aerial parts                 | Decoction                             | Baytop (1999), Tuzlacı and Tolon (2000), Gürbüz et al. (2019) |
| Adoxaceae      | Sambucus nigra L.  | W     | Elderberry, European elder | Leaves, Flowers, Fruits     | Infusion                              | Özhatay et al. (2009), Ugulu et al. (2009), Kalafatçılıar and Kalafatçılıar (2010), Yeşilada (2012), Karaköse and Karaköse (2017), Ozturk et al. (2017b) |
| Amaranthaceae  | Amaranthus retroflexus L. | W | Redroot pigweed, red-rooted pigweed | Leaves                      | Infusion                              | Arıtluk (2010), Polat et al. (2013), Sargin et al. (2013), Yeşilyurt et al. (2017b), Gürbüz et al. (2019), Olgun (2019) |
| Amaranthaceae  | Chenopodium album L. | W     | Lamb’s quarters          | Aerial parts                 | Decoction                             | Baytop (1999), Şenkardes (2014), Kılıç (2016) |
| Amaryllidaceae | Allium cepa L.     | C     | Onion, bulb onion, common onion | Bulbs, Leaves                | Eaten raw, Boiling, Juice with some honey | Cansaran and Kaya (2010), Polat et al. (2013), Gökçe (2014), Sararoglu (2014), Günbatan et al. (2016), Maranksi and Maranki (2016), Paksoy et al. (2016), Uzun and Kaya (2016), Köse (2019), Ekşi et al. (2020) |
| Amaryllidaceae | Allium sativum L.  | C     | Garlic, onion, shallot, leek, chive, Chinese onion | Leaves, Bulbs, Flowers       | Eaten raw or a tablespoon of a tincture prepared with the bulbs, lemon and vinegar is drunk 2-3 times a day | Tuzlacı (2006), Sargin et al. (2013), Gökçe (2014), Şenkardes (2014), Kılıç (2019), Ekşi et al. (2020) |
| Anacardiaceae  | Rhus coriaria L.   | CW    | Tanner’s sumach, Sicilian sumac | Leaves, Fruits               | Infusion, Spice                       | Tuzlacı and Erol (1999), Tuzlacı and Eryaşar-Aynaz (2001), Akgül et al. (2016) |
| Apioideae      | Campanula rotundifolia L. | CW | Common celandine | Seeds                        | Spike Infusion after powdering         | Baytop (1999), Gönç et al. (2018), Genç (2010), Akgül et al. (2016) |
| Brassicaceae   | Asparagus officinalis L. | CW | Wild asparagus            | Aerial parts                 | Infusion                              | Demirci and Özhatay (2012), Polat et al. (2013), Sargin et al. (2013, 2015a), Demirci-Kayran (2019), Polat (2019) |
| Berberidaceae  | Berberis aristata DC. | W | Berberis aristata DC. | Roots, Stems                | Decoction                             | Sezil et al. (1992), Arıtluk (2010) |
| Brassicaceae   | Capsella bursa-pastoris L. | CW | Shepherd’s purslane | Leaves                      | Eaten raw, Salad                       | Akan and Bakır-Sade (2015), Demirci-Kayran (2019) |
| Brassicaceae   | Erysimum cheiri (L.) Crantz | CW | Wallflower               | Flowers                      | Infusion                              | Baytop (1999), Sargin et al. (2013) |
| Brassicaceae   | Lepidium sativum L. | CW     | Garden cress             | Aerial parts                 | Infusion                              | Baytop (1999), Ugulu et al. (2009), Gökçe (2014), Bulut and Tuzlacı (2015) |
| Brassicaceae   | Raphanus rofhanistrum subsp. sativus (L.) | CW | Radish                   | Tubers                       | Eaten after mixing with some honey     | Sargin et al. (2013), Günbatan et al. (2016), Gönç (2017) |
| Cactaceae      | Opuntia ficus-indica (L.) Mill. | CW | Prickly pear, cactus pear, barbary fig | Stems, Fruits                | Cataplasm                             | Baytop (1999), Sargin and Büyükcengiz (2019) |
| Cannabaceae    | Celtis tournefortii Lam. | CW | Oriental hackberry      | Fruits                      | Decoction                             | Polat et al. (2013), Polat (2019), Olgun (2019) |
| Caprifoliaceae | Knautia orientalis L. | W     | Oriental widow flower   | Flowers                      | Infusion after drying                  | Gönç and Özhatay (2011), Gönç (2017) |
| Caprifoliaceae | Morina persica L.   | W     | Wolf’s herb            | Flowers                      | Infusion                              | Şenkardes (2014), Ozturk et al. (2017a) |
| Compositae     | Achillea alepica DC. | W     | Sweet yarrow            | Aerial parts                 | Infusion                              | Şenkardes (2014), Kılıç (2019) |
| Compositae     | Achillea filipendula L. | W | Whorl flower            | Flowers                      | Infusion                              | Tuzlacı and Erol (1999), Kılıç (2016) |
| Compositae     | Achillea millefolium L. | W | Common yarrow           | Leaves, Fruits               | Infusion                              | Bulut et al. (2017b), Yılmaz (2019) |
| Compositae     | Achillea nobilis L. subsp. sphyrea (O.Schwarz) Basler | W | Noble yarrow            | Aerial parts, Flowers         | Infusion                              | Baytop (1999), Özhatay et al. (2009), Akan and Bakır-Sade (2015) |
| Compositae     | Anthemis cotula L.  | W     | Dog fennel, stinking chamomile | Aerial parts                 | Infusion                              | Gönç and Özhatay (2011), Akgül et al. (2016), Kılıç (2016), Gönç et al. (2016), Polat (2019), Demirci-Kayran (2019), Kılıç (2019) |
| Compositae     | Artemisia absinthium L. | W | Wormwood, grand wormwood, absinthe, absinthium | Flowers, Leaves, Flowering branches, Aerial parts | Infusion after drying                 | Tuzlacı and Erol (1999), Kılıç (2016) |
| Compositae     | Bellis perennis L.  | W     | Common daisy            | Flowers                      | Infusion                              | (continued on next page)
Table 3 (continued)

| Families         | Sc. names | W/C/E | English names | Parts                          | Preparations                                      | References                                      |
|------------------|-----------|-------|---------------|--------------------------------|---------------------------------------------------|------------------------------------------------|
| Compositae       | Centaurea drabifolia subsp. floccosa (Boiss.) Wagenitz & Greuter | E     | No English name | Flowers                          | Infusion, Eaten raw by chewing                    | Özçelik et al. (2016), Karakoç and Karakoç (2017), Köse (2019) |
| Compositae       | Centaurea iberica Trevir. ex Spreng. | W     | Iberian knapsweed | Leaves                          | The juice extracted by crushing the leaves is drunk twice a day | Tuzlacı (2006), Ççek (2019) |
| Compositae       | Centaurea jacea L. | W     | Brown knapsweed, Iberian star-thistle | Aerial parts | Infusion                          | Ergül-Bozkurt and Terzioğlu (2017) |
| Compositae       | Centaurea solstitialis L. | W     | Yellow star-thistle, golden starthistle | Aerial parts | Infusion                          | Tuzlacı and Doğan (2010), Şenkardeş (2014), Bulut and Tuzlacı (2013) |
| Compositae       | Cota austriaca (Jacq.) Sch.Bip. | W     | Austrian mayweed | Aerial parts | Infusion                          | Şenkardeş (2014), Kılıç (2019) |
| Compositae       | Cota tinctoria (L.) J.Gay | W     | Golden marguerite, yellow chamomile | Flowers | Infusion                          | Ertug et al. (2004), Şenkardeş (2014), Bulut and Tuzlacı (2015), Günbatan et al. (2016), Kılıç (2016), Özçelik et al. (2016), Karakoç and Karakoç (2017), Kurt and Karagoz (2018) |
| Compositae       | Crepis vesicaria L. | W     | Beaked hawk’s-beard | Flowers                          | Infusion                                          | Özhatay et al. (2009) |
| Compositae       | Helianthus annuus L. | CW    | Common sunflower | Leaves, Flowers, Fruits          | Infusion, Decoction, Medicinal bath                | Baytop (1999), Cansaran and Yaka (2010), Kalafatçlar ve Kalafatçlar (2010), Sargin et al. (2013), Öztürk et al. (2017a) |
| Compositae       | Helichrysum arenarium (L.) Moench | W     | Dwarf everlasting, immortelle | Flowers | Decoction                          | Tuzlacı and Erol (1999), Akgül et al. (2016), Bagi et al. (2016), Günbatan et al. (2016) |
| Compositae       | Lactuca serriola L. | W     | Prickly lettuce | Aerial parts | Infusion                          | Bulut and Tuzlacı (2013), Şenkardeş (2014) |
| Compositae       | Matricaria aurea (Loefl.) Sch.Bip. | W     | Golden mayweed | Aerial parts | Infusion                          | Akgül et al. (2018), Kılıç (2019) |
| Compositae       | Matricaria chamomilla L. | W     | Chamomile, German chamomile | Aerial parts, Flowering branches, Flowers | Infusion                                          | Özer et al. (2005), Öztürk et al. (2009), Kalafatçlar ve Kalafatçlar (2010), Sargin et al. (2013, 2015a), Nacakçı and Dutkuner (2015), Akgül et al. (2016), Güneş (2017), Ibler (2017), Demirci-Kayıran (2019) |
| Compositae       | Pallenis spinosa (L.) Cass. | W     | Spiny starwort | Flowering branches, Seeds, Stems, Fruits | Eaten raw after peeling, Infusion                 | Baytop (1999), Sargin et al. (2015a), Demirci-Kayıran (2019), Kılıç (2019) |
| Compositae       | Sillybum marianum (L.) Gaerts. | W     | Milk thistle, Marian thistle | Flowers                          | Infusion                                           | Güneş ve Özhatay (2011) |
| Compositae       | Tanacetum aureum (Lam.) Greuter & al. | W     | Golden feverfew | Whole parts | Decoction                          | Baytop (1999), Sargin et al. (2015a), Demirci-Kayıran (2019), Kılıç (2019) |
| Compositae       | Tanacetum cadmeum (Boiss.) Heywood | E     | No English name | Fruits | Eaten raw, Infusion                | Tuzlacı and Erol (1999), Kocabas et al. (2017) |
| Compositae       | Tanacetum parthenium (L.) Sch.Bip. | W     | Feverfew, bachelor buttons | Flowers, Fruits | Infusion                          | Şenkardeş (2014), Günbatan et al. (2016), Karakoç ve Karakoç (2017) |
| Compositae       | Tripleurospermum collosum (Boiss. & Heldr.) E.Hossain | E     | No English name | Flowers | Infusion                          | Cansaran ve Yaka (2010), Günbatan et al. (2016) |
| Compositae       | Tripleurospermum parviflorum (Willd.) Pobed. | W     | No English name | Flowers | Infusion                          | Arıtuluk (2010), Şenkardeş (2014) |
| Compositae       | Tussilago farfara L. | W     | Coltsfoot | Aerial parts, Flowering branches, Leaves | Infusion                                          | Sargin et al. (2015a), Kılıç (2016), Bulut et al. (2017a) |
| Compositae       | Xeranthemum annuum L. | W     | Annual everlasting | Aerial parts | Decoction                          | Özhatay et al. (2009), Tuzlacı ve Doğan (2010) |
| Cornaceae        | Cornus mas L. | CW    | Cornelian cherry | Fruits | Eaten raw, Decoction, Jam         | Kocyigit ve Özhatay (2006), Polat et al. (2013), Köse (2019) |
| Cupressaceae     | Juniperus drupacea Labill. | W     | Syrian juniper | Fruits, Seeds, Cones | Decoction, Mixture                          | Ertug (2004), Sargin (2015), Kocabas ve Gediık (2016) |
| Cupressaceae     | Juniperus oxycedrus L. | W     | Cade, cade juniper, prickly juniper | Fruits, Seeds, Leaves, Tars, Cones | Decoction, Infusion                             | Tuzlacı ve Erol (1999), Tuzlacı (2006), Şenkardeş (2014), Nacakçı ve Dutkuner (2015), Sargin (2015), Sargin et al. (2015b), Günbatan et al. (2016) |
| Dioscoreaceae    | Dioscorea communis (L.) Caddick & Wilkin | W     | Black broom, lady’s-seal, black bindweed | Flowering branches, Stems | After boiling, Roasted with onions               | Sargin et al. (2013, 2015a), Bulut ve Tuzlacı (2015), Gürbüz et al. (2019) |
| Elaeagnaceae     | Hippophae rhamnoides subsp. caucasica Rousii | W     | Sanddorn, sea buckthorn | Fruits | Infusion, Syrup, jam              | Baytop (1999), Şenkardeş (2014) |
| Euphorbiaceae    | Euphorbia macrocleda Boiss. | W     | No English name | Lateral of Stem | Dropped onto a piece of bread, then swallowed. | Şenkardeş (2014), Kılıç (2019) |
| Fagaceae         | Valonia oak | W     | Cupula, Seeds | Decoction | Baytop (1999), Sargin et al. (2013, 2015a), Akan ve Bakır-Sade (2015) |

(continued on next page)
| Families | Sc. names | W/ C/E | English names | Parts | Preparations | References |
|----------|-----------|--------|---------------|-------|--------------|------------|
| Gentianaceae | *Quercus ithaburensis* subsp. *macrolepis* (Kotschy) Hedge & Yalt. | W | Common centaury, European centaury | Flowering branches | Infusion | Tuzlacı and Eryaşar-Aymaz (2001), Özhatay et al. (2009), Demirci-Kayran (2019) |
| | *Centaurium erythraea* Rafin | | | | | |
| | *Hypericum perforatum* L. | CW | St. John’s Wort | Flowering branches, Aerial parts | Infusion | Tuzlacı and Tolon (2000), Tuzlacı and Eryaşar-Aymaz (2001), Tuzlacı and Eryaşar-Aymaz (2006), Özhatay et al. (2009), Şenkardeş (2014), Sargin et al. (2015a), Güner and Selvi (2016), Gümüş (2017), Kartal and Güneş (2017), Yeşilyurt et al. (2017b), Kose (2019) |
| | *Iris jaunica* Hoffm. | E | Tall bearded iris | Flowers, Aerial parts | Infusion | Tuzlacı and Doğan (2010), Polat (2019) |
| | *Iris sert Schott ex Baker* | E | Black horehound | Leaves, Aerial parts | Infusion | Özhatay et al. (2009), Arıtuluk (2010) |
| | *Ballota nigra* L. | W | No English name | Aerial parts, Flowering branches | Infusion | Köş (2017) |
| | *Clinopodium acinos* (P.H. Davis) Brauchler & Heubl | | | | | |
| | *Cyclotrichium* originale (Labill.) Manden. & Scheng. | CW | Lavender, true lavender | Leaves | Infusion | Baytop (1999, 2000), Bozyel and Merdamert-Bozyel (2020) |
| | *Lavandula angustifolia* Mill. | | | | | |
| | *Lavandula pedunculata* subsp. *carinensis* (Boiss.) Upson & S. Andrews | W | Turkish lavender, French lavender | Flowering branches | Infusion | Baytop (1999, 2000), Ertug (2004, 2019), Arıtuluk (2010) |
| | *Lavandula stoechas* L. | CW | Spanish lavender, topped lavender | Leaves, Flowering branches | Infusion | Tuzlacı (2006), Bulut and Tuzlacı (2015), Sargin et al. (2015a, 2016, 2017a), Öçelik et al. (2016), Yeşilyurt et al. (2017b), Gürbüz et al. (2019) |
| | *Marrubium rotundifolium* Boiss. | E | Silver edged horehound | Aerial parts | Cataplasm | Özhatay et al. (2009), Güneş (2017), Demirci-Kayran (2019) |
| | *Melissa officinalis* L. | CW | Lemon balm | Aerial parts | Infusion | Kılıç ve Baeji (2013), Gökçe (2014), Sargin et al. (2015a), Güneş (2016), Yeşilyurt et al. (2017b), Polat (2019), Kılıç (2019, 2017), Gökçe (2019, 2019), Olgun (2019) |
| | *Mentha longifolia* (L.) L. | W | Horse mint, Asian mint | Leaves | Infusion | Güneş ve Özhatay (2011), Demirci ve Özhatay (2012), Polat et al. (2013), Şenkardeş (2014), Kılıç (2016), Bulut et al. (2017a), Yeşilyurt et al. (2017b), Polat (2019), Kılıç (2019), Çiçek (2019), Olgun (2019) |
| | *Mentha longifolia* subsp. *typhoides* (Briq.) Harley | W | Horse mint | Aerial parts | Teeth, Eaten raw, Infusion | Sargin et al. (2015a), Güneş ve Özhatay (2011), Demirci ve Özhatay (2012), Polat et al. (2013), Şenkardeş (2014), Kılıç (2016), Bulut et al. (2017a), Yeşilyurt et al. (2017b), Akbulut et al. (2019), Kose (2019), Yilmaz (2019) |
| | *Mentha palegium* L. | W | Pennynoyal, pennyrie, squaw mint | Leaves | Infusion | Gökçe (2014), Sargin et al. (2015a), Güner ve Selvi (2016), Yeşilyurt et al. (2017b), Akbulut et al. (2019), Kose (2019), Yilmaz (2019) |
| | *Mentha spicata* L. | W | Garden mint, spearmint, curly mint, mint, common mint | Aerial parts | Infusion | Tuzlacı ve Eryaşar-Aymaz (2001), Tuzlacı (2006), Cakıcıoğlu et al. (2011), Polat et al. (2013), Tetik et al. (2013), Gökçe (2014), Pekoz et al. (2016), Yeşilyurt et al. (2017b), Güneş (2017), Güneş et al. (2018), Polat (2019), Kose (2019) |
| | *Mentha x piperita* L. | CW | Peppermint | Leaves | Infusion with/without lemon juice, Spices | Saraç (2005), Uğulu et al. (2009), Genç (2010), Kalaflaçlar ve Kalaflaçlar (2010), Tetik et al. (2013), Şenkardeş (2014), Sargin et al. (2015a), Güneş ve Büyükkengir (2019), Güneş (2017), Yeşilyurt et al. (2017a, 2017b), Bulut et al. (2019), Demirci-Kayran (2019), Gürbüz et al. (2019), Kılıç (2019) |
| | *Micromeria myrtifolia* Boiss. & Hohen. | W | No English name | Aerial parts | Infusion, Spices | Bulut ve Tuzlacı (2015), Kökbaş ve Gedik (2016), Güneş ve Güneşemese (2018), Çiçek (2019), Sargin ve Büyükkengir (2019) |
| | *Micromeria nervosa* (Desf.) Benth. | W | No English name | Aerial parts | Infusion | Ertug (2004, 2017b) |
| | *Ocimum basilicum* L. | CW | Basil, great basil | Aerial parts | Infusion | Arıtuluk (2010), Polat et al. (2013), Tetik et al. (2013), Polat (2019) |
| | | E | No English name | Aerial parts | Infusion | Polat (2019) |

(continued on next page)
| Families | Sc. names | W/C/E | English names | Parts | Preparations | References |
|----------|-----------|-------|---------------|-------|--------------|------------|
| Lamiaceae | *Origanum acutidens* (Hand.-Mazz.) Ietsw. | E | No English name | Aerial parts, Flowering branches | Infusion | Sargin (2015), Sargin et al. (2015a) |
| Lamiaceae | *Origanum hypericifolium* O.Schwarz & P.H.Davis | W | Sweet marjoram, marjoram | Flowering branches | Infusion | Ergut et al. (2004), Bulut and Tuzlac (2015), Sargin and Büyükcengiz (2019), Demirci-Kayran (2019) |
| Lamiaceae | *Origanum onites* L. | W | Pot marjoram, Cretan oregano | Aerial parts | Infusion with/without Sage leaves | Ergut (2004), Ergut et al. (2004), Tuzlac (2006), Ugulu et al. (2009), Grez (2010), Kalafatçilar ve Kalafatçilar (2010), Sargin et al. (2013, 2015a), Göke (2014), Nacakci and Dutkuner (2015), Akbulut et al. (2019), Yilmaz (2019) |
| Lamiaceae | *Origanum saccatum* P.H. Davis | E | No English name | Aerial parts, Flowering branches | Infusion | Sargin (2015), Sargin and Büyükcengiz (2019), Gözel and Guzelşemme (2018), Demirci-Kayran (2019) |
| Lamiaceae | *Origanum syriacum* subsp. beroani (Holmes) Greuter & Burdet | W | No English name | Aerial parts, Flowering branches | Infusion | Sargin et al. (2015b), Sargin and Büyükcengiz (2019), Gözel and Guzelşemme (2018) |
| Lamiaceae | *Salvia absconditiflora* | W | Ornamental oregano | Aerial parts | Infusion | Ergut et al. (2004), Özhatay et al. (2009), Cakılcıoğlu et al. (2011), Polat et al. (2013), Göke (2014), Bulut and Tuzlac (2015), Çıçek (2019) |
| Lamiaceae | *Salvia officinalis* | W | Russian oregano | Leaves, Flowering branches, Aerial parts | Infusion | Ergut et al. (2004), Cakılcıoğlu et al. (2011), Göke (2014), Bulut (2016) |
| Lamiaceae | *Salvia officinalis* linnaeus (Link) Ietsw. | E | No English name | Aerial parts, Flowering branches, Aerial parts | Infusion | Ergut et al. (2004), Cakılcıoğlu et al. (2011), Göke (2014), Kıraköse ve Kıraköse (2017) |
| Lamiaceae | *Salvia officinalis* | W | Winter marjoram | Flowering branches | Infusion | Şenkarde (2014), Dalar et al. (2018), Çıçek (2019), Ogün (2019) |
| Lamiaceae | *Salvia officinalis* | W | No English name | Flowers, Aerial parts | Infusion | Baytop (1999), Ergül-Bozkurt veTERZIOGLU (2017), Kıraköse ve Kıraköse (2017) |
| Lamiaceae | *Rosmarinus officinalis* L. | CW | Rosemary | Leaves, Stems | Infusion | Ergut et al. (2004), Tuzlac (2006), Yesilda (2012), Saraçoğlu (2014), Bulut ve Tuzlac (2015), Güner ve Selvi (2016), Maraneci ve Maraneci (2016), Kocabas et al. (2017), Kurt ve Karaoglu (2018), Akbulut et al. (2019) |
| Lamiaceae | *Salvia absconditiflora* | E | No English name | Aerial parts, Leaves, Flowers | Cataplasm with dough | Demirci ve Özhatay (2012), Sargin (2013), Şenkarde (2014), Sargin et al. (2015a), Öztrak et al. (2017a), Küç (2019) |
| Lamiaceae | *Salvia arumensis* Rech.f. | W | Armenian salve | Leaves | Infusion | Güzel ve Guzelşemme (2018) |
| Lamiaceae | *Salvia candissima* Vahl | W | Silver sage | Leaves | Infusion | Tuzlac ve Dogan (2010), Ogün (2019) |
| Lamiaceae | *Salvia fruticosa* Mill. | W | Greek sage, Turkish sage | Aerial parts, Essential oil | Infusion, Lotion | Tanker et al. (1998), Ergut (2004), Ergut et al. (2004), Tuzlac (2006), Bulut (2016) |
| Lamiaceae | *Salvia multicaulis* Vahl | W | Many-stemmed sage | Aerial parts | Infusion, Decoction | Tanker et al. (1998), Ergut et al. (2004), Kalafatçilar ve Kalafatçilar (2010), Cakılcıoğlu et al. (2011), Yeşilda (2012), Akan ve Bakır-Sade (2015), Maraneci ve Maraneci (2016), Kurt ve Karaoglu (2018), Demirci-Kayran (2019) |
| Lamiaceae | *Salvia officinalis* L. | CW | Culinary sage, golden sage, garden sage | Aerial parts | Infusion | Tanker et al. (1998), Ergut et al. (2004), Kalafatçilar ve Kalafatçilar (2010), Cakılcıoğlu et al. (2011), Yeşilda (2012), Akan ve Bakır-Sade (2015), Maraneci ve Maraneci (2016), Kurt ve Karaoglu (2018), Demirci-Kayran (2019) |
| Lamiaceae | *Salvia palaestina* Benth. | W | Palestinian sage | Aerial parts | Infusion | Kıraköse ve Dogan (2010), Demirci-Kayran (2019) |
| Lamiaceae | *Salvia sclarea* L. | W | Clary sage, clary, clary wort | Flowering branches, Leaves | Infusion | Kıraköse ve Dogan (2010), Demirci-Kayran (2019) |
| Lamiaceae | *Salvia syriaca* L. | W | Syrian sage | Leaves, Flowers | Infusion, Steam compress | Kırık ve Dogan (2013), Şenkarde (2014) |
| Lamiaceae | *Salvia tomentosa* Mill. | W | Balsamic sage | Aerial parts | Infusion | Tuzlac ve Dogan (1999), Tuzlac ve Eryaş-Aymaz (2001), Cakılcıoğlu et al. (2004) |
| Lamiaceae | *Salvia verticillata* L. | W | Lilac sage | Leaves | Infusion | Kırık (2019), Ogün (2019) |
| Families       | Sc. names                                                                 | W/C/E | English names                                                                 | Parts                                      | Preparations          | References                                                                                     |
|---------------|---------------------------------------------------------------------------|-------|------------------------------------------------------------------------------|--------------------------------------------|-----------------------|-----------------------------------------------------------------------------------------------|
| Lamiaceae     | *Salvia viridis* L.                                                       | W     | *Horminum sage*                                                             | Leaves, Flowers                            | Infusion              | Paksoy et al. (2016), Günes (2017)                                                             |
| Lamiaceae     | *Satureja cuneifolia* Ten.                                                 | W     | *Apulian savory*                                                            | Aerial parts                               | Infusion, Decoction   | Ertug et al. (2004), Sargin et al. (2013, 2015a), Günes (2017), Kartal and Günes (2017)       |
| Lamiaceae     | *Satureja hortensis* L.                                                   | W     | *Summer savory*                                                             | Aerial parts                               | Infusion              | Ertug et al. (2004), Calcicoglu et al. (2011), Kilic and Bagci (2013), Polat et al. (2013), Tetik et al. (2013), Günes (2017), Çiçek (2019), Olgun (2019) |
| Lamiaceae     | *Satureja thymbra* L.                                                     | W     | *Thyme-leaved savory*                                                        | Aerial parts, Flowering branches, Essential oil | Infusion, Spice, Lotion | Ertug et al. (2004), Naacaci and Durkuner (2015), Sargin (2015), Sargin et al. (2015a)       |
| Lamiaceae     | *Satureja wiedemanniana* (Ave-Lall.) Velen.                               | W     | *No English name*                                                            | Aerial parts                               | Infusion              | Cansaran and Kaya (2010), Han and Bulut (2015)                                                |
| Lamiaceae     | *Sideritis arguta* Boiss. & Heldr.                                       | E     | *Leaves, Flowers*                                                           | Infusion                                   |                       | Akbulut et al. (2019), Yilmaz (2019)                                                          |
| Lamiaceae     | *Sideritis dichotoma* Huter Boiss. & Heldr.                               | E     | *No English name*                                                            | Aerial parts                               | Infusion              | Cansaran and Kaya (2010)                                                                     |
| Lamiaceae     | *Sideritis erythrantha* Boiss. & Heldr.                                   | E     | *No English name*                                                            | Aerial parts, Infusion, Gargle             |          | Ertug et al. (2004), Sargin (2015), Sargin et al. (2015b), Ozturk et al. (2017b)           |
| Lamiaceae     | *Sideritis germanicopolitana Bornm.*                                      | E     | *No English name*                                                            | Aerial parts                               | Infusion              | Han and Bulut (2015), Günbatan et al. (2016)                                                  |
| Lamiaceae     | *Sideritis huber-morathii Greuter & Burdet*                               | E     | *No English name*                                                            | Aerial parts                               | Infusion              | Guzel and Guzelsemester (2018)                                                               |
| Lamiaceae     | *Sideritis lapreatula* O. Schwarz & P.H.Davis                            | E     | *No English name*                                                            | Aerial parts                               | Infusion              | Bulut et al. (2017a), Yilmaz (2019)                                                          |
| Lamiaceae     | *Sideritis libanotica* Labill.                                            | W     | *Leaves, Flowers*                                                           | Infusion                                   |                       | Arstuluk (2010), Akbulut et al. (2019)                                                        |
| Lamiaceae     | *Sideritis libanotica* subsp. linearis (Benth.) Bornm.                   | W     | *No English name*                                                            | Aerial parts                               | Infusion              | Arstuluk (2010), Naacaci and Durkuner (2015), Demirci and Ozturk (2012)                     |
| Lamiaceae     | *Sideritis montana* L.                                                    | W     | *Mountain ironwort*                                                          | Aerial parts                               | Infusion              | Ertug et al. (2004), Paksoy et al. (2016), O zhatay et al. (2009)                            |
| Lamiaceae     | *Sideritis perfoliata* L.                                                 | W     | *No English name*                                                            | Aerial parts                               | Infusion              | Bulut and Tuzlaci (2015), Kocabas and Gedik (2016), Bulut et al. (2017a), Ozturk et al. (2017b), Guzel and Guzelsemester (2018) |
| Lamiaceae     | *Sideritis rubriflora* Hub.-Mor.                                          | E     | *No English name*                                                            | Aerial parts                               | Infusion, Gargle      | Sargin (2015), Sargin et al. (2015b)                                                          |
| Lamiaceae     | *Sideritis scarica* Griseb.                                               | W     | *Shepherd’s tea*                                                            | Aerial parts                               | Infusion              | Ertug et al. (2004), Özhatay et al. (2009), Günes (2017)                                    |
| Lamiaceae     | *Sideritis sipylea* Boiss.                                                | E     | *No English name*                                                            | Aerial parts                               | Infusion              | Ertug et al. (2004), Sargin et al. (2013, 2015a)                                             |
| Lamiaceae     | *Sideritis syriaca* subsp. nusairiensis* (Post) Hub.-Mor.                 | E     | *No English name*                                                            | Aerial parts                               | Infusion              | Şenkardeş (2014), Kocabas and Gedik (2016), Guzel and Guzelsemester (2018)                    |
| Lamiaceae     | *Sideritis tmolea* P. H. Davis                                            | E     | *No English name*                                                            | Aerial parts, Flowers                      | Infusion              | Baytop (1999), Ertug et al. (2004), Arstuluk (2010), Sargin et al. (2013, 2015a)            |
| Lamiaceae     | *Sideritis vulcanica* Hub.-Mor.                                           | E     | *No English name*                                                            | Aerial parts                               | Infusion              | Sargin et al. (2013, 2015a)                                                                  |
| Lamiaceae     | *Stachys annua* (L.) L.                                                   | W     | *Annual yellow*                                                             | Aerial parts                               | Infusion              | Ertug et al. (2004), Polat (2019), Olgun (2019)                                               |
| Lamiaceae     | *Stachys lavandulifolia* Vahl                                             | W     | *Lamb’s ear*                                                                | Aerial parts                               | Infusion              | Şenkardeş (2014), Karakoş and Karakoş (2017)                                                   |
| Lamiaceae     | *Teucrium chamaedrys* L.                                                  | W     | *Midget*                                                                   | Aerial parts                               | Infusion              | Polat et al. (2013), Sargin (2015), Sargin and Büyükengi (2019), Polat (2019), Olgun (2019) |
| Lamiaceae     | *Teucrium chamaedrys* subsp. sinuatum* (Celak.) Rech.f.                  | W     | *No English name*                                                            | Aerial parts                               | Infusion              | Tuzlaci (2006), Tuzlaci and Dogan (2010), Kaval et al. (2014)                                 |
| Lamiaceae     | *Teucrium polium* L.                                                      | W     | *Hulwort, felty germander, mountain germander*                             | Aerial parts                               | Infusion              | Polat et al. (2013), Kaval et al. (2014), Polat (2019)                                      |
| Lamiaceae     | *Thymbra capitata* (L.) Cav.                                              | W     | *Spanish oregano, cone-head thyme*                                          | Aerial parts, Flowering branches, Essential oil | Infusion, Lotion, Spice | Ertug et al. (2004), Sargin (2015), Sargin et al. (2015a), Yilmaz (2019)                    |
| Lamiaceae     | *Thymbra sintenisii* Bornm. & Azn.                                        | W     | *No English name*                                                            | Aerial parts                               | Infusion              | Ozturk et al. (2017a), Bulut et al. (2019)                                                   |
| Lamiaceae     | *Thymbra spicata* L.                                                      | W     | *Thyme spiked*                                                              | Aerial parts                               | Infusion, Lotion, Spice |                                                                                  |

(continued on next page)
| Families                  | Sc. names                             | W/C/E | English names | Parts                      | Preparations                      | References |
|--------------------------|---------------------------------------|-------|---------------|----------------------------|-----------------------------------|------------|
| Lamiaceae                | *Thymus ciliaticus* Boiss. & Balansa   | W     | Cilician thyme | Aerial parts               | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus haussknethii* Velen.          | E     | No English name| Leaves                    | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus kotschyanus* Boiss. & Hohen.  | W     | No English name| Aerial parts               | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus longicaulis* C. Presl          | W     | Creeping thyme | Flowering branches, Aerial parts | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus longicaulis* subsp. chaubardti (Rchb.f.) Jalas | W | No English name | Aerial parts | Infusion |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus migricus* Klokov & Des.-Ghos. | W     | No English name| Leaves                    | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus nummularius* M. Bieb.         | W     | No English name| Flowering branches         | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus praecox* subsp. jankae (Celak.) Jalas | W | No English name | Leaves                    | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus revolutus* Celak.             | E     | No English name| Aerial parts               | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus sipyleus* Boiss.              | W     | No English name| Aerial parts               | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus transcaucasicus* Ronniger     | W     | No English name| Whole parts                | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Thymus sygioides* Griseb.            | W     | No English name| Aerial parts, Flowering branches | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Vitex agnus-castus* L.               | W     | Chaste tree, Abraham’s balm | Seeds | Decoction, Swallowing |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Ziziphus capitata* L.                | W     | No English name| Aerial parts               | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Ziziphus clinopodioides* Lam.        | W     | Blue mint bush | Aerial parts               | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Ziziphus taurica* M.Bieb.            | W     | No English name| Aerial parts               | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Ziziphus taurica* subsp. cleoniodioides (Boiss.) P.H. Davis | E | No English name | Aerial parts | Infusion |            |
|                         |                                       |       |               |                            |                                   |            |
| Lamiaceae                | *Ziziphora tenuior* L.                | W     | No English name| Aerial parts               | Infusion                          |            |
|                         |                                       |       |               |                            |                                   |            |
| Lauraceae                | *Laurus nobilis* L.                   | CW    | Laurel, true laurel, bay, royal bay, sweet bay, Grecian laurel | Leaves, Seeds | Infusion of the leaves with/ without quince leaves after drying and pulverizing, Decoction of the seeds |            |
|                         |                                       |       |               |                            |                                   |            |
| Leguminosae              | *Ceratonia siliqua* L.                | CW    | Carob, carob tree | Fruits |            |            |
|                         |                                       |       |               |                            |                                   |            |
| Leguminosae              | *Glycyrrhiza glabra* L.               | CW    | Licorice, liquorice | Leaves, Roots | Infusion after pulverizing |            |
|                         |                                       |       |               |                            |                                   |            |
| Leguminosae              | *Trifolium repens* L.                 | W     | Dutch clover | Aerial parts | Infusion |            |
|                         |                                       |       |               |                            |                                   |            |

(continued on next page)
| Families | Sc. names | W/C/E | English names | Parts | Preparations | References |
|----------|----------|-------|---------------|-------|--------------|------------|
| Lythraceae | *Punica granatum* L. | CW | Pomegranate | Fruits | Eaten raw, Juice | Baytop (1999), Kocabaş and Gedik (2016), Demirci-Kayıran (2019) |
| Malvaceae | *Alcea calvartii* (Boiss.) Boiss. | W | No English name | Aerial parts | Infusion, Decoction | Akaç and Bakır-Sade (2015), Küç (2016), Oztürk et al. (2017a) |
| Malvaceae | *Alcea excubita* Iljin | W | No English name | Flowers, Leaves | Infusion, Decoction | Tuzlacı and Dogan (2010), Küç (2016) |
| Malvaceae | *Alcea palilda* (Wild.) Waldst. & Kit. | W | Hollyhock, eastern hollyhock | Flowers, Fruits, Aerial parts | Infusion, Decoction | Artüzük (2010), Bulut et al. (2017a) |
| Malvaceae | *Althea rosea* | W | W | Flowers, Roots | Infusion | Şenkardeş (2014), Akgül et al. (2016), Demirci-Kayıran (2019) |
| Malvaceae | *Althea pallida* Waldst. & K. Boiss. | W | Garden hollyhock, rose mallow | Leaves, Flowers, Roots | Infusion | Akgül et al. (2018), Küç (2019) |
| Malvaceae | *Althea setosa* (Boiss.) Alef. | W | Bristly hollyhock | Flowers, Fruits | Infusion | Akgül et al. (2018), Küç (2019) |
| Malvaceae | *Althea striata* Alef. | W | No English name | Flower, Fruits | Infusion | Baytop (1999), Genç (2010), Kalfaşatlar ve Kalfaşatlar (2010), Sargin et al. (2015b), Demirci-Kayıran (2019) |
| Malvaceae | *Althaea officinalis* L. | CW | Common marsh | Buds, Flowers | Infusion | Baytop (1999), Kalfaşatlar ve Kalfaşatlar (2010), Sargin et al. (2015b), Demirci-Kayıran (2019) |
| Malvaceae | *Malva neglecta* Wallr. | W | Cheeseplant, dwarf mallow | Aerial parts | Infusion, Decoction | Tuzlacı ve Erol (1999), Cakılcıoğlu et al. (2011), Kılıç ve Bagçi (2013), Polat et al. (2013), Tekiç et al. (2013), Kavak et al. (2014), Şenkardeş (2014), Dalar et al. (2018), Olgu (2019) |
| Malvaceae | *Malva sylvestris* (L.) Mill. | W | Large-flowered mallow, high mallow | Aerial parts | Roasted with rice, radish, onion and butter, Infusion | Şenhatay et al. (2009), Polat et al. (2013), Nacıçık ve Dutkuner (2015), Sargin et al. (2015a), Dalar et al. (2018), Demirci-Kayıran (2019), Köse (2019) |
| Malvaceae | *Tilia cordata* Mill. | W | Bast, small-leaved linden | Leaves, Fruits | Decoction with cinnamon and cloves | Sarac (2005), Kalfaşatlar ve Kalfaşatlar (2010), Gökoç (2014), Şenkardeş (2014), Akgül et al. (2016), Maranki ve Maranki (2016), İşler (2017), Yeşilürt et al. (2017b) |
| Malvaceae | *Tilia platyphyllos* Scop. | W | Broad-leaved lime | Flowers, Bracts | Infusion | Sarac (2005), Kalfaşatlar ve Kalfaşatlar (2010), Bulut ve Tuzlacı (2013), Gökoç (2014), Maranki ve Maranki (2016), Bulut et al. (2017a), İşler (2017) |
| Malvaceae | *Tilia rubra* subsp. *caucasica* (Rupr.) V.Engl. | W | No English name | Flowers, Leaves, Barks | Infusion, Decoction | Sarac (2005), Tuzlacı (2000), Tuzlacı ve Eyyap-Aynaz (2001), Sarac (2005), Ozhatay et al. (2009), Sargin et al. (2013), Gökoç (2014), Bulut ve Tuzlacı (2015), Güner ve Selvi (2016), Üzun ve Kayalı (2016), Maranki ve Maranki (2016), İşler (2017), Karakoçoğlu ve Karakoçoğlu (2017), Köse (2019) |
| Malvaceae | *Tilia tomentosa* Moench | CW | European white lime, silver lime, silver linden | Leaves, Flowers, Fruits, Barks, Roots | Infusion, Decoction | Tuzlacı ve Tolon (2000), Tuzlacı ve Eyyap-Aynaz (2001), Sarac (2005), Ozhatay et al. (2009), Sargin et al. (2013), Gökoç (2014), Bulut ve Tuzlacı (2015), Akgül et al. (2016), Maranki ve Maranki (2016), İşler (2017), Yeşilürt et al. (2017a, 2017b), Guzel ve Guzellemiş (2018), KURT ve Karaoğlu (2018), Gürbüz et al. (2019) |
| Moraceae | *Ficus carica* L. | CW | Fig, common fig | White mulberry | Fruits, Leaves | Eaten after drying, Infusion Syrup | Sargin et al. (2013, 2015a), Köse (2019) Cakılcıoğlu et al. (2011), Şenkardeş (2014), Olgu (2019) |
| Moraceae | *Morus alba* L. | CW | Fig, common fig | White mulberry | Fruits, Leaves | Eaten after drying, Infusion Syrup | Sargin et al. (2013, 2015a), Köse (2019) Cakılcıoğlu et al. (2011), Şenkardeş (2014), Olgu (2019) |
| Myrtaceae | *Eucalyptus camaldulensis* Dehnh. | CW | Murray red gum, red gum, river red gum, long-break eucalyptus | Essential oils | The 2% infusion is sweetened with honey and drunk 2-3 glasses a day. Medicinal bath, frankincense | Karamanoğlu (1977), Tanker et al. (1998), Baytop (1999), Ergu (2004), Sarac (2005), Genç (2010), Kalfaşatlar ve Kalfaşatlar (2010), Oztürk et al. (2017a) |
| Myrtaceae | *Eucalyptus globulus* Labill. | CW | Blue gum, southern blue gum | Essential oils | The 2% infusion is sweetened with honey and drunk 2-3 glasses a day. Medicinal bath, frankincense | Karamanoğlu (1977), Tanker et al. (1998), Baytop (1999), Sarac (2005), Genç (2010), Kalfaşatlar ve Kalfaşatlar (2010), Oztürk et al. (2017a) |
| Nitriaceae | *Peganum harmala* L. | W | Harmal peganum | Seeds | Infusion | Yeşilürt et al. (2017a), Bulut et al. (2019), Demirci-Kayıran (2019) |
| Oleaceae | *Fračius fruticosus* subsp. *citriaca* (Lingelsh.) Yalt. | E | No English name | Stems, Barks | Infusion | Demirci ve Özhatay (2012), Oztürk et al. (2017a) |
| Oleaceae | *Olea europea* L. | CW | Olive, common olive | Fixed oils | Cataplasm with one tablespoon molasses, tarahana and flour | Tuzlacı (2006), Nacıçık ve Dutkuner (2015), Sargin et al. (2015a), Köse (2019) |
| Orchidaceae | *Dactylorhiza sp.* | E | No English name | Tubers | Infusion (with some milk after powdering) | Şenkardeş (2014), Sargin (2015), Sargin ve Büyükçengiz (2019) |
| Orchidaceae | *Orchis anatolica* Boiss. | W | Orchid | Tubers | Infusion, Spice (after powdering) | Baytop (1999), Sargin (2015), Oztürk et al. (2017b) |
| Papaveraceae | *Papaver orientale* L. | W | Great scarlet poppy | Seeds | Roasted with garlic | Tanker et al. (1998), Baytop (1999), Güneş ve Özhatay (2011) |
| Families          | Sc. names                  | W/ C/E | English names                  | Parts                  | Preparations                        | References                                                                 |
|-------------------|---------------------------|-------|--------------------------------|------------------------|-------------------------------------|-----------------------------------------------------------------------------|
| _Pinaceae_        | *Pinus sylvestris* L.     | CW    | Redwood, Scots fir             | Buds, Resins, Cones, Essential oils | Decoction, Medicinal bath, frankincense | Kalafatçilar and Kalafatçilar (2010), Karaköse and Karaköse (2017), Gürbüz et al. (2019) |
|                   |                           |       |                                |                        |                                     |                                                                              |
| _Rosaceae_        | *Potentilla speciosa* Willd. | W     | Leafy Spurge                   | Leaves                 | Decoction                          | Özhatay et al. (2009), Ozçelik et al. (2016), Gürbüz et al. (2019)          |
|                   | *Prunus avium* (L.) L.    | CW    | Sweet cherry                   | Fruits stalks          | Paste (from tarhana flour and rye seeds, honey or molasses) | Sargin et al. (2015a), Çiçek (2019), Gürbüz et al. (2019)               |
|                   | *Prunus cerasifera* Ehrh. | CW    | Cherry plum                    | Fruits                 | Eaten raw, Infusion, Decoction      | Özbay et al. (2009), Teterik et al. (2013), Çiçek (2019)                  |
|                   | *Prunus laurocerasus* L. | W      | Laurel cherry                   | Leaves                 | Infusion with Cudonia leaves         | Bayt (2009), Gürbüz et al. (2019)                                         |
|                   | *Prunus mahaleb* L.       | CW    | Mahaleb cherry                 | Leaves                 | Infusion                            | Bayt (2009), Gürbüz et al. (2019)                                         |
|                   | *Prunus spinosa* L.       | W      | Sloe, blackthorn               | Fruits                 | Eaten raw, Decoction                | Özhatay et al. (2009), Yeşilıdyrt et al. (2017b)                          |
|                   | *Rosa × damascena* Herrm. | CW    | Rose, damask rose              | Fruits                 | Infusion                            | Bayt (2009), Ozçelik et al. (2017a), Gürbüz et al. (2019)                  |
|                   | *Rosa × damalis* Bechst. | CW    | Glaucous northern dog rose     | Fruits, Leaves         | Decoction, Infusion                 | Polat et al. (2013), Polat et al. (2019), Gürbüz et al. (2019)            |
|                   | *Rosa boissieri* Crp.     | W      | Rose                           | Leaves, Fruits         | Infusion Decoction                  | Tuzlacı (2006), Gürbüz et al. (2019)                                      |
|                   | *Rosa canina* L.          | CW    | Dog rose, briar rose, common briar | Flowers, Petals, Roots, Stems | Eaten raw, Infusion, Decoction, Jam, Marmalade | Tuzlacı and Tolon (2000), Kılıç et al. (2014), Olgun (2019)                |
|                   |                           |       |                                |                        |                                     |                                                                              |
| *continued on next page*  |                           |       |                                |                        |                                     |                                                                              |
Tables

Table 3 (continued)

| Families            | Sc. names                        | W/C/E | English names          | Parts                           | Preparations                     | References                                      |
|---------------------|----------------------------------|-------|------------------------|---------------------------------|-----------------------------------|------------------------------------------------|
| Rosaceae            | *Rosa hemisphaerica* Herrn.      | W     | Sulphur rose           | Fruits                          | Eaten raw, Decoction               | (2010), Tuzlacı and Doğan (2010), Cakıcıoğlu et al. (2011), Günes and Özhatay (2011), Demirci and Özhatay (2012), Yeşilda (2012), Bulut and Tuzlacı (2013), Kilic and Bagci (2013), Polat et al. (2013), Sargin et al. (2013, 2015), 2015b, Tetik et al. (2013), Kaval et al. (2014), Şenkardeş (2014), Bulut and Tuzlacı (2015), Nacali and Dutkuner (2015), Akgil et al. (2016), Bağcı et al. (2016), Bulut (2016), Güner and Selvi (2016), Ozturk et al. (2017a), Paksoy et al. (2016), Üzün and Kaya (2016), Bulut et al. (2017a, 2017b), Ergül-Bozkurt and Terziolu (2017), Karakoç and Karakoç (2017), Yeşilyurt et al. (2017b), Dalar et al. (2018), Günes et al. (2018), Guzel and Güzelemse (2018), Polat (2019), Akbulut et al. (2019), Çiçek (2019), Demirci-Kayran (2019), Gürbüz et al. (2019), Kılıç (2019), Kose (2019), Sargin and Büyükcengiz (2019) |
| Rosaceae            | *Rosa montana* Lindl.            | W     | Yellow rose            | Fruits                          | Decoction, Jam                     | Günes and Özhatay (2011)                      |
| Rosaceae            | *Rubus canescens* DC.            | W     | Woolly blackberry      | Leaves                          | Infusion                           | Özhatay et al. (2009), Kalfaşçilar and Kalfaşçilar (2010), Polat et al. (2013), Polat (2019), Akbulut et al. (2019) |
| Rosaceae            | *Rubus sanctus* Schreb.          | W     | Holy bramble           | Fruits, Roots, Flowers          | Eaten raw or after drying, Decoction, Infusion, Jam, Marmalade | Ergül (2004), Kalfaşçilar and Kalfaşçilar (2010), Şenkardeş (2014), Sargin et al. (2015a), Günes et al. (2018), Kılıç (2019), Çiçek (2019), Olgun (2019) |
| Rutaceae            | *Citrus* spp.                    | CW    | Oranges, lemons, grapefruits, pomelos, limes | Fruits, Pericarps | Dropped in teas and soups, Juice (sweetened with sugar), Gargle, Eaten fresh, Jam, Marmalade, Hot mush (externally) | Baytop (1999), Ergül (2004), Sarac (2005), Genc (2010), Sagoğlu et al. (2013), Gökçe (2014), Alan and Baker-Sade (2015), Gürbüz et al. (2019), Kılıç (2019) |
| Sapindaceae         | *Aesculus hippocastanum* L.      | CW    | Horse-chestnut, conker tree | Seeds                          | Peeled, minced, then swallowed      | Baytop (1999), Gürbüz et al. (2019), Kose (2019) |
| Sapindaceae         | *Scrophularia chrysantha* Jaub. & Spach | W     | Figwort                | Whole parts                     | Decoction after drying             | Günes and Özhatay (2011)                      |
| Solanaceae          | *Physalis alkekengi* L.          | W     | Bladder cherry         | Fruits                          | Eaten raw, Decoction               | Karkois and Karkois (2017), Ozturk et al. (2017b) |
| Urticaceae          | *Urtica dioica* L.               | W     | Stinging nettle, perennial nettle, tall nettle, common nettle | Aerial parts (without flowering) | Infusion                            | Tuzlacı and Erol (1999), Kilic and Bagci (2013), Polat et al. (2013), Özer et al. (2005), Tetik et al. (2013), Kaval et al. (2014), Şenkardeş (2014), Sargin et al. (2015a), İşler (2017), Ozturk et al. (2017a, 2017b), Kılıç (2019) |
| Urticaceae          | *Urtica urens* L.                | W     | Small nettle           | Aerial parts                     | Infusion                            | Tuzlacı and Erol (1999), Özer et al. (2005), Cakıcıoğlu et al. (2011), Şenkardeş (2014), İşler (2017), Yeşilyurt et al. (2017a, 2017b) |
| Violaceae           | *Viola sieheana* W.Becker         | W     | No English name        | Flowers                         | Infusion                            | Özhatay et al. (2009), Karkois and Karkois (2017) |
| Violaceae           | *Viola sauris* M.Bieb.           | W     | Russian violet, Common grapevine, grapevine, table grape | Aerial parts, Fruits, Seeds | Infusion, Eaten raw or dried, Cataplasm (with tarhana flour), Molasses | Ergül-Bozkurt and Terziolu (2017), Tuzlacı (2006), Polat et al. (2013), Sargin et al. (2013, 2015a), Kılıç (2019), Kose (2019) |
| Vitaceae            | *Vitis vinifera* L.              | CW    |                           |                                 |                                   |                                                |

W: Wild plants, C: Cultivated plants, WC: Wild and cultivated plants, E: Endemic plants. Boldly highlighted taxa (which are 189 in total and their anti-influenza effects have not been investigated experimentally yet). 
* The plants that were also identified to be used in the treatment of malaria.

35 (15.6%) taxa found between the investigation results in the world literature and ethnobotanical results of the study was found to be 92.9%. This result may prove the fact that for centuries, the locals have been equally justified in their preferences of plant usage.

3.5. Comparative evaluation of active compounds

Taxa containing quercetin, which has a typical polyphenol structure with anti-influenza activity, are *Hypericum perforatum*, *Morus alba* and *Papaver rhoas* (Kim et al., 2010; Liu et al., 2016; Kim and Chung, 2018) (Table 4). It is not accidental that we detected quercetin and chlorogenic acid as the most common active gradients in our screening records, because these compounds are found to be the most effective compounds used in the treatment of influenza. Supporting these findings, Kumar et al. (2003) stated in a study of mice that quercetin (Fig. 3A) may be useful as a drug to reduce oxidative stress caused by influenza virus...
infection in the lungs, and to protect them from the toxic effects of free radicals. In another study, Wu et al. (2016) stated that quercetin, which shows inhibitory activity in the early stage of influenza infection, offers a future therapeutic option for developing effective, safe and affordable natural products for the treatment and prophylaxis of influenza virus infections. Moreover, Nile et al. (2020), in an investigation of the antiviral and cytotoxic effects of quercetin 3-glucoside (Q3G) from Dianthus superbus, Q3G (Fig. 3B) found that this substance showed strong antiviral activity against influenza A and B viruses. Therefore, they emphasized that it could be developed and used as a natural anti-influenza drug.

On the other hand, chlorogenic acid (CHA) is a caffeoylquinic acid constituent (Fig. 3C) found in many vegetables and fruits traditionally used in Turkish folk medicine, such as Cydonia oblonga, Crataegus monogyna, Morus alba, Hypericum perforatum, Eucalyptus globules (Baytop, 1999; Ding et al., 2017; Kim and Chung, 2018). Indeed, many researchers including Ding et al. (2017) and Ren et al. (2019) have pointed out that CHA acts as a neuraminidase blocker to inhibit influenza A virus at both in vitro and in vivo levels, thus they stated that CHA is potentially beneficial in the treatment of influenza.

Among the researches, the taxa containing the most active compounds in terms of anti-influenza activity were Glycyrrhiza glabra (11 chemicals with 31.4% out of the 35), Papaver rhoeas (7; 20.0%), Morus alba (5; 14.3%) and Punica granatum (4; 11.4%) (Table 4). Glycyrrhiza glabra (licorice) is among the oldest and most popular traditional herbal medicines worldwide (Grienke et al., 2014). Also, its roots are one of the most frequently used parts for treating respiratory tract infections in Turkish folk medicine (Baytop, 1999; Ertug, 2004). Hence, the roots may have appeared to have the greatest number of active ingredients in the screening. This result overlaps with the findings of Grienke et al. (2014) because they had emphasized that the accumulation of the plant components exhibits 3D similarities to known flu Neuraminidase inhibitors (which are key enzymes in viral replication and the first-line drug target to fight influenza) according to their basis of a shape-focused virtual screening. Therefore, this finding may be pointing out that this plant is more effective and specific than other taxa in terms of anti-influenza activity.

3.6. Ecotic plants

In addition, 9 medicinal exotic herbs were detected to have been traditionally used in the treatment of influenza and sold in herbal and public markets. Zingiber officinale (ginger), Curcuma longa (turmeric), Syzygium aromaticum (cloves), Piper nigrum (black pepper) and Cinnamomum verum (cinnamon) are examples of these plants. Information on which parts, methods, and how often these plants are used in flu treatment is given in Table 5. The citrus species presented in Table 3 are actually exotic species. For several centuries, they have mainly exhibited a distribution in the Aegean and Mediterranean coasts in Turkey’s flora. Citrus limon (lemon), C. sinensis (orange), C. reticulata (tangerine), C. paradisi (grapefruit) and C. x aurantium (citrus) are among these types. Eucalyptus camaldulensis and E. globulus (Eucalyptus trees), another plant that has settled in the flora, are of Australian origin and have been used in forestry, roadside landscaping, drying of the marshes and folk medicine practices, such as combating malaria, since the Ottoman era (Ozgün, 2013).

The point we should especially emphasize here is that, while herbal products to be released for the treatment of influenza are determined by World Health Organisation (WHO) and the European Phytotherapy Scientific Cooperative (ESCOP), and controlled by the Turkish government, these standard practices are not yet available for fresh or dried plant taxa that are traditionally consumed and sold in public markets and herbalist shops in Turkey. Besides, it can never be ignored that medicinal plants are very successful in preventing and treating influenza if used according to the prescriptions specified in their pharmacopoeia. Thus, it is necessary to record traditional-empirical practices with proven trial-and-error methods urgently, to demonstrate their activities and active ingredients in vitro or in vivo studies, and to enlighten the public by adding optimal tariffs to their pharmacopoeia by the relevant official standard institutions.

In our study, it was also determined that 27 endemic plants were used effectively in influenza treatment and collected from nature. The unconscious collection of endemic and endangered species in the red list of the International Association for Nature Conservation (IUCN) should be more carefully monitored using laws, media and educational tools and methods, and the necessary precautions should be urgently taken.

4. Conclusion

Although the first choice for influenza control and reducing the effects of epidemics is a vaccine, it is also known that it is not the fastest and most effective option since modifications in viral proteins require annual adaptation of the influenza vaccine formulation, as noted by Nachbagauer and Palese (2020). Considering the side effects and complications of antiviral medicines, the search for more effective remedies for fast-spreading pandemic influenza strains continues intensively all over the world today.

Due to their easy production, low cost, water-solubility, low toxicity and selective effects, medicinal plants, especially herbal essential oils and antiviral compounds found in their aqueous extracts are the most...
Table 4
Worldwide anti-influenza activity research results of the taxa detected in the study.

| Plant species | Active compounds identified (and used parts) | Mechanism of action | References |
|---------------|---------------------------------------------|---------------------|------------|
| *Alcea rosea* L. | Not specified (Aerial parts) | Elicits antiviral innate immune responses in serum, bronchoalveolar lavage fluid, small intestinal fluid, and the lungs | Kim et al. (2018) |
| *Allium cepa* L. | Not specified (Bulbs) | Decreases Hemagglutination Assay (HA) titers and destroys the avian influenza virus subtype H9N2, and the propagation of the virus | Ahmadi et al. (2018) |
| *Allium sativum* L. | Allicin (Bulbs) | Inhibits viral nucleoprotein synthesis and polymerase activity | Chavan et al. (2016), Ding et al. (2017) |
| *Crataegus monogyna* Jacq. | Chlorogenic acid (Fruits) | Inhibits neuraminidase activity and blocks the release of newly formed virus particles from infected cells | Hamaou et al. (2005) |
| *Cydonia oblonga* Mill | Chlorogenic acid, 3-Caffeoylquinic acid (Fruits) | Inhibit influenza viral activity and no effect on hemagglutination inhibition | |
| *Eucalyptus camaldulensis* Dehnh. | Not specified (Leaves) | Inhibit virus replication completely | Sadaatrosul et al. (2017) |
| *Eucalyptus globulus* Labill. | 1,8-cineole (Leaves, Essential oil) | Increase the production of influenza-specific serum immunoglobulin (Ig) G2a antibodies, stimulate mucosal secretory IgA (s-IgA) responses at the nasal cavity, improve the expression of respiratory tract intraepithelial lymphocytes (IELs) in the upper respiratory tract, and promote dendritic cell (DC) maturation and the expression of co-stimulatory molecules | Li et al. (2017) |
| *Eucalyptus globulus* Labill. | Mentofin (Leaves, Essential oil) | Inactivate Avian Influenza Virus (AIV) | Barbour et al. (2010) |
| *Eucalyptus globulus* Labill. | 1,8-cineole (Leaves, Essential oil) | Increase the production of influenza-specific serum immunoglobulin (Ig) G2a antibodies, stimulate mucosal secretory IgA (s-IgA) responses at the nasal cavity, improve the expression of respiratory tract intraepithelial lymphocytes (IELs) in the upper respiratory tract, and promote dendritic cell (DC) maturation and the expression of co-stimulatory molecules | Li et al. (2017) |
| *Eucalyptus globulus* Labill. | Mentofin (Leaves, Essential oil) | Inactivate Avian Influenza Virus (AIV) | Barbour et al. (2010) |
| *Eucalyptus globulus* Labill. | Citronellol and Eugenol (Leaves, Essential oil) | Inhibit the replication of both influenza A and B viruses at the lowest effective concentration | Kim et al. (2010) |
| *Glycyrrhiza glabra* L. | 3,4-dihydro-8,8-dimethyl-2H,8H-benzo dipyran-3-ol, Biochanin B, Glabrol, Glabrone, Hesperaglabridin B, Licoflavone B, Licorice glycoside B, Licorice glycoside E, Liquiritigenin, Liquiritin, Prunin (Roots) | Taken together, it was proposed that chlorogenic acid and quercetin could be employed as the effective lead compounds for anti-influenza A H1N1 due to having strong binding abilities with neuraminidase. | Pourghanbari et al. (2016) |
| *Hypericum perforatum* L. | Hypercin (Flowers) | Inhibit virus-induced cytopathic effect; ie: Lung consolidation and loosening of lung virus titers. | Pu et al. (2009) |
| *Hypericum perforatum* L. | Isoqueretin (Flowers) | Inhibit the replication of both influenza A and B viruses at the lowest effective concentration | Kim et al. (2010) |
| *Hypericum perforatum* L. | Chlorogenic acid and Quercetin (Flowers) | Taken together, it was proposed that chlorogenic acid and quercetin could be employed as the effective lead compounds for anti-influenza A H1N1 due to having strong binding abilities with neuraminidase. | Liu et al. (2016) |
| *Malius domestica* Borkh. | 5-Caffeoylquinic acid (Fruits) | Inhibit influenza viral activity and no effect on hemagglutination inhibition | Hamaou et al. (2005) |
| *Matricaria chamomilla* L. | Borneol (Flowers-Essential oil) | Inhibit the replication of the influenza virus A (H1N1) | Sokolova et al. (2017) |
| *Melissa officinalis* L. | Not specified (Leaves) | Inhibit the HA (hemagglutinin) activity, but not the NA (Neuraminidase) activity | Jalali et al. (2016) |
| *Melissa officinalis* L. | Not specified (Leaves) | Inhibit replication of AVI through the different virus replication phase, especially throughout the direct interaction with the virus particles | Pourghanbari et al. (2016) |
| *Melissa officinalis* L. | Tannin (Leaves) | Aqueous extracts of the melissa plant blocked hemadsorption by parainfluenza viruses, but the tannin of this plant has no effect on influenza A and B viruses in hemagglutination and hemadsorption. | Kucera and Herrmann (1967) |
| *Mentha s piperita* L. | Menthene and Pulegone (Leaves) | Show good antiviral effects in infected mice. | Qi et al. (2012) |
| *Mentha s piperita* L. | Mentofin (Leaves, Essential oil) | Inactivate Avian Influenza Virus (AIV) | Barbour et al. (2010) |
| *Morus alba* L. | Cyanidin-3-rutinoside, Rutin, Cyanidin-3-glucoside, Quercetin, Chlorogenic acid (Fruit juice and seeds) | Exhibit 1.3 log inhibition in the pre- and cotreatment of the virus against FL04, a type B virus. Also exhibited significant DPPH radical scavenging and ferric ion-reducing activities in a dose-dependent manner. | Kim and Chung (2018) |
| *Nigella sativa* L. | Not specified (Seeds) | Enhance immune responsiveness and suppress pathogenicity of influenza viruses in turkeys | Umar et al. (2016) |
| *Olea europaea* L. | Not specified (Leaves) | Blocks the receptor site of the viruses | Mehmood et al. (2018) |
| *Olea europaea* L. | Not specified (Leaves) | Shows significant antiviral activity. Olive oil was included in formulations to ameliorate its potential cytotoxic effects. | Vimalanathan and Hudson (2012) |
| *Olea europaea* L. | Not specified (Fruits) | Both in influenza A/H1N1 and HRV14, replication cycle and progeny virus production were significantly decreased after the | Tseliou et al. (2019) |

(continued on next page)
| Plant species | Active compounds identified (and used parts) | Mechanism of action | References |
|--------------|-----------------------------------------------|---------------------|------------|
| *Salvia fruticosa* | β-carotene and Linalool acid (Aerial parts) | Decrease influenza virus activation by inhibiting the hemagglutination | Mancini et al. (2009) |
| *Origanum vulgare* L. | Carvacrol (Essential oil) | Shows significant antiviral activity. Olive oil was included in formulations to ameliorate its potential cytotoxic effects. | Vimalanathan and Hudson (2012) |
| *Origanum vulgare* L. | Not specified (Essential oil) Linalool (Essential oil) Linalool (Essential oil) | Reduce visible cytopathic effects of influenza A/WS/33 virus activity by > 52.8%. | Choi (2018) |
| *Papaver rhoes* L. | Kaempferol-3-sophoroside, Kaempferol-3-neohesperidoside, Kaempferol-3-sambubioside, Kaempferol-3-glucoside, Quercetin-3-sophoroside, Luteolin, Chelanthifoline (Pollen) | Display noncompetitive inhibition of H3N2 neuraminidase and reduce the severity of virally induced cytopathic effects | Lee et al. (2016) |
| *Peganum harmala* L. | Not specified (Seeds) | Inhibit cytopathic effect of influenza virus | Moradi et al. (2017) |
| *Pimpinella anisum* L. | Not specified (Essential oil) Linalool (Essential oil) | Reduce visible cytopathic effects of influenza A/WS/33 virus activity by > 52.8%. | Choi (2018) |
| *Punica granatum* L. | Not specified (Seeds) | Inhibit cytopathic effect of influenza virus | Moradi et al. (2017) |
| *Punica granatum* L. | Ellagic acid, Caffeic acid, Luteolin, and Punicalagin (Fruit juice) | Suppress replication of influenza A virus and inhibit viral RNA replication and agglutination of chicken red blood cells by influenza virus | Haidari et al. (2009) |
| *Salvia fruticosa* Mill. | Not specified (Aerial parts-Essential oil) | Both in influenza A/H1N1 and HRV14, replication cycle and progeny virus production were significantly decreased after the treatment with CAPeo (An essential oil combination based on three aromatic plants; *Thymbra capitata, Origanum dictumans* and *Salvia fruticosa* in extra-virgin olive oil) | Tseliou et al. (2019) |
| *Salvia officinalis* L. | Citronelol and Eugenol (Leaves, Essential oil) 1,8-Cineole and α-Thujone (Leaves) | Inhibits the hemagglutinin activity, but not the Neuraminidase activity | Vimalanathan and Hudson (2014) |
| *Salvia sclarea* L. | Not specified (Essential oil) Linalool (Essential oil) Linalool (Essential oil) | Reduce visible cytopathic effects of influenza A/WS/33 virus activity by > 52.8%. | Choi (2018) |
| *Sambucus nigra* L. | Not specified (Fruits) | Reduce hemagglutination and inhibit the replication of human influenza viruses | Zakay-Rones et al. (1995) |
| *Sambucus nigra* L. | Not specified (Fruits) | Reduce visible cytopathic effects and inhibit at an early point in infection, probably by rendering the virus non-infectious | Chen et al. (2014) |
| *Sambucus nigra* L. | Not specified (Fruits) | Decrease virus titer and inhibit viral protein synthesis or virus particle release. | Shahsavandi et al. (2017) |
| *Sambucus nigra* L. | Not specified (Fruits) | Suppress viral replication in the bronchoalveolar lavage fluids and increase the level of the IFV-specific neutralizing antibody in the serum | Kinoshita et al. (2012) |
| *Sambucus nigra* L. | Not specified (Fruits) | Exhibit a specific neumarinidase-inhibiting effect | Krawitz et al. (2011) |
| *Silybum marianum* (L.) Gaertn. | Silymarin (Seeds) | Reduces cytopathic effect (CPE) and inhibits viral mRNA synthesis with no cytotoxicity | Song and Choi (2011) |
| *Thymus capitata* (L.) Cav. | Carvacrol (Essential oil) | Shows significant antiviral activity. Olive oil was included in formulations to ameliorate its potential cytotoxic effects. | Vimalanathan and Hudson (2012) |
| *Thymus capitata* (L.) Cav. | Apigenin, Thymol (Aerial parts-Essential oil) | Both in influenza A/H1N1 and HRV14, replication cycle and progeny virus production were significantly decreased after the treatment with CAPeo (An essential oil combination based on three aromatic plants; *Thymbra capitata, Origanum dictumans* and *Salvia fruticosa* in extra-virgin olive oil) | Tseliou et al. (2019) |
| *Urtica dioica* L. | Lectin (Roots) | Inhibit mannosidases in host cells rendered the progeny viruses more sensitive to the mannoise-binding agents and even to the N-acetylglucosamine-binding *Urtica dioica* agglutinin | Van der Meer et al. (2007) |
| *Vitis vinifera* L. | Not specified (Fruits) | Exhibit the prevention of the virus infectivity and the antioxidant activities (DPPH scavenging capacity and superoxide anion radical scavenging capacity) | Bekhit et al. (2011) |
| *Coca tinctoria* (L.) J. Gay | Not specified (Aerial parts) | No correlation was found between antiviral activity and fatty acid contents of the extracts. | Orhan et al. (2009) |
| *Ficus carica* L. | Not specified (Aerial parts) | The results indicated that the prepared emulsions could elicit a little degree of immunity, but they could not inhibit the anamnestic response and infection. | Najari et al. (2015) |
| *Olea europaea* L. | Not specified (Fruits) | The results indicated that the prepared emulsions could elicit a little degree of immunity, but they could not inhibit the anamnestic response and infection. | Najari et al. (2015) |
| *Origanum acutidens* (Hand.-Mazz.) leotsw. | Carvacrol (Flowers-Essential oil) | None of the extracts inhibited the reproduction of influenza A/ Aichi virus in MDCK cells | Sokmen et al. (2004) |
| *Rosmarinus officinalis* L. | Carnosic acid (Aerial parts) | Inhibit both A- and B- type hRSV, while it does not affect the replication of influenza A virus | Shin et al. (2013) |
| *Teucrium polium* L. | Not specified (Aerial parts) | No significant effects on influenza virus infectivity | Derakhshan et al. (2015) |

* The taxa that have no significant result for virus inactivation.
studied natural ingredients in recent times (Grienke et al., 2009). Therefore, natural products such as traditional herbs show great promise in the development of potentially effective new antiviral drugs. Particularly, recent studies on phytochemicals, such as quercetin, chlorogenic acid, mentofin, and linalool abundantly found in many plants and vegetables, eliminate the efforts and huge costs of finding lots of antiviral vaccines that need to be renewed every year and allow us to be more optimistic about the successful management of the next influenza outbreaks.

Turkey has remarkable potential for serious research on this topic due to having vast ethnomedicinal experience and the richest flora of Europe and the Middle East. This study, conducted in this regard, is the first nationwide ethnomedical screening study conducted on flu treatment with plants in Turkey. In particular, we would like to emphasize that the most common detected genus members, such as *Sideritis* (16 taxa; 7.1%), *Salvia* (12; 5.4%), *Thymus* (12; 5.4%), and *Origanum* (10; 4.5%) may be more efficient in terms of the anti-influenza targeting than other genera for the interest of the sectors that are researching new natural drug sources.

Through this study, we strongly recommend these 35 (15.6%) plants, which have proved their high anti-influenza activities and inhibition potentials in the experimental studies, to be subject to clinical research and for widespread use in the near future. Also, with 189 (84.4%) taxa detections that have not been investigated yet, it is an important resource for both national and international pharmacological researchers. Clinical research and evaluation studies required for standard compliance for human use, starting especially with the fifteen plant taxa whose use records against both malaria and influenza were presented in this study, can be begun. With a possible mass production of one or more malaria-like drugs, a significant contribution can be provided to the resource for both national and international pharmacological researches.

Through this study, we strongly recommend these 35 (15.6%) plants, which have proved their high anti-influenza activities and inhibition potentials in the experimental studies, to be subject to clinical research and for widespread use in the near future. Also, with 189 (84.4%) taxa detections that have not been investigated yet, it is an important resource for both national and international pharmacological researchers. Clinical research and evaluation studies required for standard compliance for human use, starting especially with the fifteen plant taxa whose use records against both malaria and influenza were presented in this study, can be begun. With a possible mass production of one or more malaria-like drugs, a significant contribution can be provided to the indigenous people living in that region and to the national economy. Therefore, more experimental studies are urgently needed to understand

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**Table 5**

Exotic plants used for influenza treatment in Turkish folk medicine.

| Families          | Sc. Names                | Local names | English names | Parts       | Preparations                  | Homeland        | References                  |
|-------------------|--------------------------|-------------|---------------|-------------|-------------------------------|-----------------|-----------------------------|
| Combretaceae      | *Terminalia chebula*     | Kara halile | Black myrobolan | Unripe      | Decoction or infusion (after pulverizing) | South Asia      | Baytop (1999), Akan and Bakır-Sade (2015) |
| Lauraceae         | *Cinnamomum verum* J.Prstl | Tarçın, darçın | Cinnamon, true cinnamon tree | Bark       | Decoction or infusion (after pulverizing) | South and Southeast Asia | Baytop (1999), Kocabaş and Gedik (2016), Gürbüz et al. (2019) |
| Lythraceae        | *Lawsonia inermis* L. | Kına, kına otu | Hina, henna , mignonette tree, Egyptian privet | Leaves | Infusion of 1% is used in the treatment of lung inflammation. To reduce fever in infants, it is mixed with dried mint, honey and eggs and applied externally to the baby's chest and back. | Northeast Africa | Baytop (1999), Gänbatan et al. (2016), Demirci-Kayran (2019) |
| Myrtaceae         | *Syzygium aromaticum* (L.) Merr. & L.M. Perry | Karanfil | Flower buds, Essential oil | Unripe | Infusion prepared with mint (*Mentha × piperita*) is consumed after the addition of honey. | India           | Baytop (1999), Güneş (2017), Gürbüz et al. (2019) |
| Piperaceae        | *Piper nigrum* L. | Kara biber, karahali | Black pepper | Unripe | Infusion prepared with mint (*Mentha × piperita*) is consumed after the addition of honey. | India           | Baytop (1999), Güneş (2017), Gürbüz et al. (2019) |
| Rubiaceae         | *Cinchona pubescens* Vahl | Kanakuna, kanakuna ağacı | Red chinchona, quina | Bark | 15–30 g of liqueur or wine, containing sulfate salts, is drunk 3 times a day. | Central and South America | Baytop (1999) |
| Zingiberaceae     | *Zingiber officinale* Roscoe | Zencefil | Ginger | Rhizomes | Dried and pulverized rhizomes are used as an infusion or eaten by mixing with honey | South Asia      | Baytop (1999), Sargin et al. (2013), Akan and Bakır-Sade (2015), Kocabaş and Gedik (2016), Gürbüz et al. (2019), Demirci-Kayran (2019) |
| Zingiberaceae     | *Alpinia officinarum* Hance | Havlucan, havlucan | Lesser galangal | Rhizomes | Decoction or infusion (after pulverizing) | Southeast Asia | Baytop (1999), Sargin et al. (2013), Akan and Bakır-Sade (2015), Kurt and Karagul (2018) |
| Zingiberaceae     | *Curcuma longa* L. | Zerdeçal, Hinta, safran, safran kokü, sanboya, zerdeçav | Turmeric | Rhizomes | Decoction or infusion (after pulverizing) with/without lemon and zingiber. Eaten a coffee spoonful with some honey, twice a day. | Indian subcontinent and Southeast Asia | Baytop (1999), Akan and Bakır-Sade (2015) |

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**Fig. 3.** The chemical structures of quercetin (A), quercetin 3-glucoside (B) and chlorogenic acid (C).
The true value of these plants. Based on the data to be obtained, we believe that the future extension of anti-influenza studies, including plant taxa that are frequently used in Turkish folk medicine, would be a more effective option.

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