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Plants used in complementary medicine in the treatment of respiratory tract diseases in Türkiye

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Türkiye'de solunum yolu hastalıklarının tedavisinde tamamlayıcı tıp uygulamalarında kullanılan bitkiler

Abstract: In this study, the plants used in complementary medicine for the treatment of respiratory tract diseases in Turkey have been researched. The study was carried out in two stages: literature study and fieldwork. As a result of the study, it was determined that 73 plant species have been used as complementary medicine in the treatment of respiratory tract diseases. The genera which have the most species are *Salvia* L., *Thymus* L., *Origanum* L., *Alcea* L., *Datura* L., *Lavandula* L., *Malva* L., *Pinus* L. and *Verbascum* L. The rest of the genera are represented with one species. The most commonly used plant species are *Salvia* sp., *Thymus* sp., *Tilia* L. sp., *Mentha* L. sp., *Lavandula* sp., *Origanum* sp., *Thymbra spicata* L., *Mrytus communis* L., *Rosmarinus officinalis* L. Bioactive compounds found in many of these plants; carvacrol, alkaloids, saponins, steroids, tannins, glycosides, anthocyanins, terpenes and other secondary metabolites. According to the results of the literature and field studies it has been determined that these plants are used effectively within the scope of complementary medicine against asthma, bronchitis, chronic cough, influenza, flu, sinusitis, pharyngitis, shortness of breath and tuberculosis. Most of these plants are used in the treatment of all respiratory tract infections without distinguishing the type of infection among the public. As a result; it was determined that 73 plant species researched in this study have the potential to be used in the treatment of respiratory tract diseases. With further studies, there are possibilities to develop phytochemicals for use in the treatment of respiratory tract diseases from these plants.

Key words: complementary medicine, respiratory tract diseases, asthma and bronchitis, cough, tuberculosis

Özet: Bu çalışmada Türkiye'de solunum yolu enfeksiyonlarının tedavisinde tamamlayıcı tıp uygulamalarında kullanılan bitkiler araştırılmıştır. Araştırma literatür çalışması ve halk arasında yapılan saha çalışmaları olmak üzere iki aşamalı olarak gerçekleştirilmiştir. Yapılan çalışma sonunda 73 bitki türünün solunum yolu enfeksiyonlarının tedavisinde tamamlayıcı tıp uygulamalarında kullanıldığı belirlenmiştir. En fazla tür içeren cinsler şunlardır; *Salvia* L., *Thymus* L., *Origanum* L., *Alcea* L., *Datura* L., *Lavandula* L., *Malva* L., *Pinus* L. and *Verbascum* L. Diğer cinsler ise birer türle temsil edilmektedir. En yaygın kullanılan bitki türleri; *Salvia sp.*, *Thymus* sp., *Tilia* L. sp., *Mentha* L. sp., *Lavandula* sp., *Origanum* sp., *Thymbra spicata* L., *Mrytus communis* L., *Rosmarinus officinalis* L. Bu bitkilerin çoğunda bulunan biyoaktif bileşikler; karvakrol, alkaloitler, saponinler, steroitler, tanenler, glikozitler, antosiyaninler, terpenler ve diğer sekonder metabolitler. Yapılan literatür ve saha çalışmaları sonuçlarına göre bu bitkiler; astım, bronşit, kronik öksürük başta olmak üzere, grip, nezle, sinüzit, farenjit, nefes darlığı ve tüberküloza karşı tamamlayıcı tıp kapsamında etkili bir şekilde kullanıldığı belirlenmiştir. Ancak belirlenen bu bitkilerin büyük bir çoğunluğu halk arasında enfeksiyon tipi ayırt edilmeden tüm solunum yolu enfeksiyonlarının tedavisinde kullanılmaktadır. Sonuç olarak; bu çalışmada incelenen 73 bitki türünün solunum yolu enfeksiyonlarının tedavisinde kullanılabilme potansiyelinin olduğu belirlenmiştir. Yapılacak ayrıntılı çalışmalarla bu bitkilerden solunum yolu enfeksiyonlarının tedavisinde kullanılmaya uygun fotokimyasalların geliştirilme olanakları bulunmaktadır.

Anahtar Kelimeler: tamamlayıcı tıp, solunum yolu enfeksiyonları, astım ve bronşit, öksürük, tüberküloz

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1. Introduction

Respiratory tract infections are generally grouped under two main headings: upper (Pharyngitis, Laryngitis, Flu, Sinusitis) and lower (Asthma, Bronchitis, COPD, Tuberculosis, Pneumonia) respiratory tract infections. However, clinical findings of upper respiratory tract infections are very similar. For this reason, it has been reported that defining local infections above the larynx as upper respiratory tract infections will be more practical in terms of clinical approach (Akan, 2012).

Viruses (RSV, rhinovirus, parainfluenza, influenza A, B, adenovirus, coronaviruses) are causative agents in 80-90% of acute respiratory infections; *Streptococcus pneumoniae* (Klein 1884) Chester 1901, *Haemophilus influenzae* (Lehmann and Neumann 1896) Winslow et al. 1917, *Mycoplasma pneumonia* Somerson et al. 1963 and *Bordetella pertussis* (Bergey et al. 1923) Moreno-López 1952 are the most common agents among bacteria (Akşit, 2002; Mufson, 2000). Respiratory tract diseases are one of the most common diseases in childhood. Acute respiratory tract infections are shown as one of the most important causes of mortality and morbidity for children (Aydın et al., 2015). According to the 2018 Türkiye Statistical Institute data, respiratory tract diseases in Türkiye ranks 3rd leading cause of death (Anonymous, 2020). According to the data of the World Health Organization (WHO), respiratory

infections are responsible for 13% of the causes of death in children under the age of 5 (Aydın et al., 2015).

According to data from 2017, it has been reported that respiratory tract diseases are the third leading cause of death after cardiovascular diseases and neoplasms worldwide (Soriano et al., 2020). In addition, respiratory infections cause significant loss of workforce and lessons for students. It is reported that an adult catches cold on average 2 times a year and a child who goes to kindergarten 6-7 times (Akan et al., 2012). With this feature, it is seen that respiratory diseases have a great impact on human life as they affect the quality of life and cause loss of workforce.

The inability to fully treat some respiratory diseases, the desire for rapid recovery of the patients or the economic inadequacies, direct people to use traditional and complementary medicine methods. According to Türkiye Traditional and Complementary Medicine regulations using herbs under complementary medicine is one of the 15 accepted methods (Resmi Gazete, 2014). Scientifically unproven herbal treatment may have negative consequences such as side effects and drug interactions that may seriously affect human health. Although it is known, the tendency towards traditional and complementary medicine practices is gradually increasing. According to the World Health Organization, complementary medicine practices are used at a rate of 80% in Africa, 70% in Canada, 48% in Australia, 42% in America, 38% in Belgium, and 49% in France (Hazır and Bozkurt, 2020).

There are about 12.000 plant species and subspecies in Türkiye; it is known that about 500 of these plants are used in traditional and complementary medicine. In Türkiye, 447 varieties of medicinal and aromatic plants are traded, 139 of them exported abroad (Özgüven et al., 2005; Öztürk et al., 2017). In Türkiye, local people to collect plants from nature traditionally and continue to use them in the treatment of various diseases from past to present. Also, herbalists sell these plants, which are permitted to be sold in spice-sellers and pharmacies. Ethnobotanical and clinical studies conducted in recent years show that herbal therapies have an important place among Complementary and Alternative Medicine methods in respiratory tract infections (Yücel and Yücel, 2020).

In this study, it is aimed to determine the plants used in traditional and complementary medicine in the treatment of respiratory tract diseases in Türkiye.

2. Material and Method

This study was carried out in two stages in line with the determined objectives. Firstly all the resources which might be relevant, especially ethnobotanical studies in Türkiye, pharmacopeia, and monographs were examined (Ağca, 2011; Aksu, 2011). In the next stage, face-to-face interviews with local people were made with field studies. As a result of the studies, plants used in Türkiye in traditional and complementary medicine against respiratory tract diseases were determined, made a list, and are given as a table.

3. Results

As a result of the literature and field studies, 73 plant varieties used within the scope of traditional and complementary medicine practices were determined (Fig. 1). The names of the plants, their bioactive compounds, and their effects on respiratory tract infections are given in Table 1.

Among the plants determined in this study, the genera containing the most species are; *Salvia* L. (5.48%), *Thymus* L. (5.48%), *Alcea* L. and *Origanum* L. (4.11%); *Datura* L., *Lavandula* L., *Malva* L., *Mentha* L., *Pinus* L. and *Verbascum* L. (2.74%) (Fig. 1). Other genera are represented by only one species (1.37%). The most commonly used plant species are; *Salvia* L. sp., *Thymus* sp., *Tilia* L. sp., *Mentha* sp, *Lavandula* sp., *Origanum* sp., *Thymbra spicata* L., *Mrytus communis* L., *Rosmarinus officinalis* L.

Table 1. Plants used in complementary and alternative medicine applications in the treatment of respiratory tract diseases in Türkiye

Names of the Plants	Bioactive Compounds	Effects on Respiratory Tract Infections	References
Abies nordmanniana (Steven) Spach	Resin acids, monosaccharides, Alcohols, lignans, glycerol, gallic acid, sucrose, catechin isomers, gallocatechin isomers, etc.	Asthma and bronchitis prevention	Ermiş (1997), Yücel (2014)
Alcea officinalis L.	Tannin, alanine, arginine, lysine, asparagine, coumarin, altein, mucilage, quercetin, kaempferol, pectin etc.	Asthma and bronchitis prevention	Rotblatt (2000), Yücel (2008), Shah et al. (2011), Sağlam (2011)
Alcea pallida Waltdst. & Kit- *Alcea rosea* L.	Starch, sucrose, galactose, pectin, oil, tannin, asparagine, mucilage, etc.	Against cold and bronchitis	Yücel (2014), Şimşek et al. (2002), Altay et al. (2015), Ermiş (1997)
Allium schoenoprasum L.	Cysteine, alkanyl, anthocyanin-flavonol 3 " - acetate etc.	Against cold and flu	Yücel (2014)
Ammi visnaga L.	Resin, fixed oil, visnagin, meladinin, kellin etc.	Asthma and cough reliever	Baytop (1999), Yücel (2008), Uz (2011), Kökçü et al. (2015)
Artemisia annua L.	Resin, artemisia ketone, camphor, 1.8-cineole etc.	Against tuberculosis and bronchitis	Yücel (2014), Altay et al. (2015)
Bellis perennis L.	Polyacetylene, tannin, saponin, flavonoid etc.	Against cough and upper respiratory tract disease	Yücel (2008), Melikoğlu et al. (2015)
Borago officinalis L.	Linoleic acid, oleic acid, palmitic acid, stearic acid, eicosenoic acid, erucic acid, gallic acid, oleuropein etc.	Preventing respiratory diseases	Yücel (2014), Al-Rubaye et al. (2017)

Bryonia cretica L.	Saponin, lectin, resin, tannin, choline, etc.	Against asthma, bronchitis, and cough	Yücel (2014)
Cannabis sativa L.	Cannabinoids, oil, lecithin, choline, globulen, resin, alkaloid etc.	Prevents dyspnea and cough	Yücel (2008), Altay et al. (2015)
Castanea sativa Mill.	Tannins; potentillin, pedunculagin, castalagin and vescalagin, quercetin, flavonoids, oil, pectin, sugar, vitamin C, β-sitosterol, glycoside etc.	Preventing asthma, bronchitis, and cough	Ermiş (1997), Yücel (2008), Sargın et al. (2013), Eminağaoğlu et al. (2017)
Cichorium intybusm L.	Mucilage, fructose, levulin, coumarin glycoside, tannin, inulin, pentozones etc.	Against asthma	Öztürk and Özçelik (1991), Yücel (2008), Melikoğlu et al. (2015)
Cotinus coggygria Scop.	Tannin, flavone derivatives, gallic acid, quercetin, penta-O-galloyl-β-d-glucose, butine, taxsipholin, catechin fustine, sulfuretin etc.	Preventing cold, sinusitis, bronchitis	Yücel (2014), Melikoğlu et al. (2015)
Crataegus monogyna Jacq.	Amine, tannin, rutin, hyperoside, vitamin C, vitex, triterpene, flavone etc.	Preventing asthma	Yücel (2008), Şöhretoğlu (2011), Şengün and Yücel (2015)
Crocus pallasii Goldb.	Organic acids, sugars, crocin etc.	Preventing asthma, bronchitis, and cough	Zengin et al. (2020), Yücel (2014)
Datura inoxia Mill.	Atropine, scopolamine, saponins, flavonoids, cardiac glycosides, phenols etc.	Preventing asthma	Yücel (2014), Melikoğlu et al. (2015)
Datura stramonium L.	Atropine, saponins, tannins, alkaloids, glycosides etc.	Asthma treatment	Yücel (2014), Melikoğlu et al. (2015)
Descurainia sophia (L.) Webb ex Prantl	Bromoxynil, thifensulfuron methyl, clopyralid etc.	Against chronic cough and asthma	Yücel (2014)
Ecballium elaterium (L.) A. Rich.	Cucurbitacin, elaterin, carbohydrate, saponin, etheric oil, flavonoid, etc.	Preventing sinusitis	Yücel ve Tülükoğlu (2000), Yücel (2014)
Echinacea purpurea (L.) Moench	Elaterin, chlorogenic and caffeic acid, xyloglucan, alkaloids, amino acids and derivatives, etc.	Flu and common cold	Yale and Liu (2004), Sharma et al. (2006), Yücel (2014)
Echinophora tenuifolia L. *ssp. sibthorpiana* (Guss,) Tutin	Methyl eugenol, d-3-carene, p-cymene, α-phellandren etc.	Preventing cold, flu, and respiratory diseases	Chalchat et al. (2011), Gökbulut et al. (2013), Şengün and Öztürk, 2018 (2018)
Ephedra majör Host	Tannin, ephedrine, norephedrine, etc.	Against asthma	Asımgil (1997), Yücel (2008)
Glycyrrhiza glabra L.	Triterpenic saponins, sterol, glycosides, coumarin, linolenic acid, coumarins, tryptamine, indolo, pyrazine, pyrrolidine, salicylic acid, asparagine, betaine, chelite, glycyrrhizin, isoflavones, steroids, lecithin, protein etc.	Preventing cold, flu, dyspnea, cough; expectorant	Aksu (2011), Yücel (2014), Sargın et al. (2013)
Inula helenium L.	Helenin, isochostic acid, tomentozine, inhibitoroz, 1, 2-longidinone, iso-velleral, methyl ester, quercetin, chiapin B, inulin, etc.	Cough and upper respiratory tract diseases treatment	Yücel (2014)
Lavandula angustifolia Mill.	α and β-pinene, sabinen, o-cimene, limonene, eucalyptol, beta cis ocimene, α-terpinene, p-mentha-1,4 (8) diene, linalool, camphor, erpinen-4-ol, α-terpinol, linalyl anthralinate, geraniol acetate, B-caryophilene, B-bergamotene, B-farnesen, etc.	Preventing cough, bronchitis, asthma, respiratory diseases	Baytop (1999), Yücel (2008), Eröztürk (2002)
Lavandula x intermedia Emeric ex Loisel.	linalool, linalyl acetate, 1,8-cineole, terpinen-4-ol Lavandulyl acetate, borneol α-pinene, camphene, β-pinene, myrcene, α-phellandrene, limonene, 1,8-cineole, (Z)-β-ocimene,γ-terpinene trans-β-ocimene, terpinolene, o-cymene	Preventing cough, bronchitis, asthma, respiratory diseases	Baytop (1999), Yücel (2014), Eröztürk (2002)
Leonurus cardiaca L.	Flavonoids, terpenes, chlorogenic acid, orientein, quercetin, hyperoside rutin etc.	Against asthma	Yücel (2014)
Liquidambar orientalis Mill.	Cinnamic acid, styracin, styrol, styrone, storesinol, storegenin, terpinen-4-ol, α- terpinol, sabinene, and γ-terpinene, styrene, α-pinene, camphenene, β-pinene, cinnamyl alcohol, limonene, acetophenone, petylphenol, 3-phenyl propanol etc.	Against asthma	Asımgil (1997), Yücel (2008), Melikoğlu et al. (2015)
Malva neglecta Wallr.	Anthocyanidin compounds such as mucilage, malvidin, delphinidin and malvin, tannins, mucilage, flavones, protein etc.	Anti-pharyngitis	Polat et al. (2015), Korkmaz and Karakurt (2015), Güner and Selvi (2016)

Malva sylvestris L.	Mucilage, pectin, malvin, malvidin, glycoside, flavonol, tannin, anthocyanin; pentadecenoic, palmitic, stearic, oleic, linoleic, linolenic, arachidic, arachidonic, behenic, lignoceric and nervonic acid etc.	Cough suppressant, against asthma	Asımgil (1997), Yücel (2008), Melikoğlu et al. (2015)
Marrubium vulgare L.	2-hexenal, α-phellandrene, α-pinene, β-phellandrene, β-pinene, m-myrene, α-limonene, sabinen, caryophyllene, β-farnesene, marubin, tannin etc.	Preventing cough, bronchitis and asthma	Yücel (2012)
Matricaria recutita (L.) Rauschert	Chamazulene, 1,8-cineole, β-pinene, α-pinene, α-bisabolol, farnacene, bisabolon, terpinene, apigenin, apigetrin, apiin, luteolin, quercetin, quercitrin, quercimetrin, chrysoeryol, umbelliferon, heniarin etc.	Preventing cough, bronchitis and asthma	Şimşek et al., (2002), Yücel (2012), Melikoğlu et al. (2015)
Mentha longifolia (L.) Huds.	Mentton, 1.8 cineole, terpineol-4, menthol, pulegone, piperitone, germakrene, caryophyllene, thymol, α-humulene, α-longipinen etc.	Against cough, bronchitis, cold, dyspnea	Güneş and Özhatay (2011), Yücel (2012), Melikoğlu et al. (2015)
Mentha x piperita L.	Menttone, menthyl acetate, neomenthol, isomenthone, menthofuran, limonene, pulegon, α-pinene, β-pinene, resin, carvone, pinene, tripertene, menthyl acetate, tannin etc.	Against cough, cold, dyspnea	Ağca (2011), Yücel (2014)
Mrytus communis L.	Myrtenyl acetate, 1,8-cineol, α-pinene, linalool, limonene, linalyl acetate, geranyl acetate, α-terpineol etc.	Against asthma, bronchitis, sinusitis, cough	Yücel (2014), Melikoğlu et al. (2015)
Ocinum basilicum L.	Linalol, epi-α-cadinol, a-bergamoten, γ-cadinene, estragole, 1,8-cineol, methylchavikol, methylcinnamate, linolene, rosmarinic acid, citral, eugenol, geraniol, pinene etc.	Cough suppressant	Eröztürk (2002), Yücel (2008), Korkmaz and Karakurt (2015)
Orchis masculata (L.) L.	E-ocimen, limonene, 3-hexenyl acetate, linalool, β-Terpineol, a-pinene, sabinene, limonene, carvone, p-caryophylene, p-farnesene, myrcene, glucose, glucomannan, starch, mucilage etc.	Cough and bronchitis preventive	Yücel (2014)
Origanum majorana L.	Terpinen-4-ol, cis-sabinen hydrate, p-cymene, γ-terpinene, linalool, carvacrol, glycoside etc.	Cough and bronchitis preventive	Yücel (2012), Polat et al. (2015)
Origanum sipyleum L.	γ-terpinene, p-cymene, thymol methyl ether, carvacrol methyl ether, thymol, carvacrol etc.	Cough suppressant, respiratory tract diseases preventive	Yücel (2014)
Origanum vulgare L.	Carvacrol, terpinen-4-ol, linalol, sabinen, α-terpinen, γ-terpinen thymol, cymen, etc.	Cough and bronchitis preventive	Polat et al. (2015), Eminağaoğlu et al. (2017)
Papaver rhoeas L.	p-hydroxybenzoic acid, protocatechuic acid, ethanol, kaempferol, kerempetol, quercetin, luteolin, flavonoids, astragalin, hyperoside, glycosides, isoquercitrin etc.	Cough suppressant, bronchitis preventive	Yücel and Tülükoğlu (2000), Yücel (2014), Melikoğlu et al. (2015)
Petasites hybridus (L.) Gaertn., Mey. & Scherb.	Sesquiterpenes, alkaloids, petasin, petasol, hydroxylase, buteonate, isopetasin etc.	Cough, bronchitis and cold preventive	Yücel (2014)
Phlomis fruticosa L.	β-caryophylene, (E) -methyl isoeugenol, α-asaron, germakrene D, γ-bisabolen, α-pinene etc.	Respiratory tract diseases preventive	Yücel (2014)
Phragmites australis (Cav.) Trin. ex Steud.	Carbohydrates, glycosides, protein, asparagine, vanillic acid, hydroxy benzaldehyde, Mg, K, manganese etc.	Bronchitis preventive	Yücel (2008), Uysal et al. (2010)
Physalis peruviana L.	Carotene, polyphenols, protein, lipids, inoleic acid, oleic acid, palmitic acid, palmitoleic acid, gadoleic, erucic, lignoceric, nervonic acid, papain, Fe, Mg, Zn; Vitamin A, C, B1, B2, B6, B12 etc.	Asthma preventive	Yücel (2014)
Pinus nigra Arnold *subsp. pallasiana* (Lamb.) Holmboe	Resin, fixed oil, linoleic, oleic, anteiso, pinolenic and coniferonic acid, protein, cellulose, phenols etc.	Tuberculosis and respiratory diseases preventive	Baytop (1999), Yücel (2008), Melikoğlu et al. (2015)
Pinus sylvestris L.	Resin, fixed oil, syadonic, sciadonic acid, limonene, protein, cellulose, essential oil, etheric oil, mineral salt, vitamin B-C-K, tannin, etc.	Against cold and dyspnea	Yücel (2008), Sağıroğlu et al. (2012), Korkmaz and Karakurt (2015)
Pistacia terebinthus L.	Resin, α-pinene, β-pinene, limonene, terpinen-4-ol, α-terpineol, essential and fixed oils etc.	Dyspnea, asthma, bronchitis, cough preventive	Yücel (2014), Melikoğlu et al. (2015)
Plantago lanceolata L.	Flavonoids, hydroxycinnamic acids, carboxylic acid, coumarin, aucubin and iridoid glycoside, mucilage, saponin, alkaloid, K, Zn, tannin and silicic acid etc.	Against bronchitis, cold, sinusitis and asthma	Ertuğ (2004), Yücel (2014), Güner, and Selvi, 2016
Rosa cannina L.	Ascorbic acid, flavonoids, dimethyl sulfide, protein, tannin, Na, K, P, Mn, Mg, vitamin C, A, B, flavone, malic acid, pectin, citronellol etc.	Cough and cold preventive	Eröztürk (2002), Şimşek et al. (2002), Yücel et al. (2019)
Rosmarinus officinalis L.	Rosmarin, phenolic diterpenes, carotenoid, p-cymene, linalool, γ-terpinene, thymol, beta-pinene, α-pinene, 1,8-cineol, camphor, verbenone, borneol, etc.	Asthma and respiratory tract diseases preventive	Şimşek et al. (2002), Yücel (2008)

Salvia cadmica Boiss.	Tannin, alkaloids, phenols, tannins, glycosides, steroids, 1, 2 cyclohexanediol, salicyl alcohol, stearic acid, linolenic acid, galactose 4,6-0-nonylidene, thion, krypton, 1.8-cineol, borneol etc.	Respiratory tract diseases preventive	Şimşek et al. (2002), Koyuncu et al. (2010), Yücel (2014)
Salvia fruticosa L.	α-pinene, campene, β-pinene, 1,8-cineol, γ-terpinene, cis-tujone, trans-thujone, camphor, terpinen-4-ol, trans- (E) -caryophylene, aromadendrene, α- humulen etc.	Tuberculosis prevention	Yücel (2014), Ertuğ (2004), Koyuncu,et al. (2010)
Salvia officinalis L.	Thujon, viridiflorol, caryophyllene, apigein, polysaccharide, 1,8-cineol, linalool, borneol, salven, pinene, camphor, vitamin C and A, phytonzides; triterpenoids ursolic, oleanolic acid etc.	Respiratory tract diseases preventive	Ceylan (1996), Baytop (1999), Yücel (2008)
Salvia sclarea L.	α-thujene, α and β-pinene, camphene, myrcene, α-hexandrene, α-terpinene, p-cymene, limonene, sabinene, linalool oxide, fenchone, terpinolene, linalol, camphor, borneol, myrtenol, piperitone, β-caryophyllene , sclareol etc.	Respiratory tract diseases preventive	Ceylan (1996), Koyuncu et al. (2010), Korkmaz and Karakurt (2015)
Santolina chamaecyparissus L.	1,8-cineol and β-eudesmol, ketone, camphor, beta-phellandren etc.	Asthma, bronchitis, tuberculosis preventive	Yücel (2008, 2014)
Sedum acre L.	Edacrine, flavonol, glycoside, cedinine sedacryptine, n-methyl anabasine, thujone, borneol, 1,8-cineol, camphor, salvin, tannin, fumaric acid, borneol acid, malic acid, oxalic acid, sedamine, sedridine, cedinone, nicotine etc.	Stimulating the respiratory center	Yücel (2008, 2014)
Sinapis arvensis L.	Erythritol, Nitro-2-propanol, Furfural, Cyclopentanemethylamine, 1-Butene, 4-isothiocyanato, difluorobenzene, Eicosanoic acid, phenylmethyl ester, trigonelline, estragole, pentanenitrile, eugenol, maltose, monoacetate, tributyl acetylcitrate, docosenoic acid, phthalic acid, γ-tocopherol, tetraacetate, campesterol , γ-sitosterol	Preventing asthma and bronchitis	Yücel (2014)
Solanum nigrum L.	Gentic acid, luteolin, apigenin, kaempferol, m-coumaric acid, anthocyanidin, glycoalkaloid, tannin, saponin, linoleic acid, palmitic acid, solanine etc.	Preventing bronchitis and cough	Ermiş (1997), Yücel (2008)
Teucrium polium L.	α- β-pinene, p-cymene, germakrene D, carvacrol, α-copaene, spathulenol, α-tugen, sabinene, β-mirre, limonene, benzene, linalol, caryophyllene, α-carmine etc.	Preventing sinusitis	Yücel (2014), Altay et al. (2015)
Thymbra spicata L.	Carvacrol, gamma-terpinene, p-cymene, thymol, terpinene, borneol etc.	Preventing respiratory tract diseases	Yücel (2008), Sargın et al. (2013)
Thymus citriodorus (Pers.) Schreb.	Borneol, thymol, 3,7-dimethyl-1,6-octadien-3-ol, cyclohexene, terpene, camphor etc.	Against cough, bronchitis, cold, respiratory diseases	Koyuncu,et al. (2010), Altay et al. (2015)
Thymus leucostomus Hausskn. et Velen var. *argillaceus* Jalas	Flavonoid, linalool, resin, tannin, thymol and carvacrol	Against cough, bronchitis, cold, respiratory diseases	Polat et al. (2015), Yücel et al. (2011)
Thymus longicaulis C. Presl	Limonene, thymol, geraniol, geranyl acetate, linalool, α-terpinyl acetate etc.	Against cough, bronchitis, cold, respiratory diseases	Yücel (2008), Altay et al. (2015)
Thymus vulgaris L.	Camphor, α-β-pinene, 1.8-cineol, borneol, carvacrol, linalool, geraniol, borneol, p-cymene, γ-terpinene, thymol etc.	Against cough, bronchitis, cold, respiratory diseases	Yücel (2014), Altay et al. (2015), Melikoğlu et al. (2015)
Tilia rubra DC.	Flavonoid, glycoside, quercetin, quercitrin, apigenin, luteolin, hexadecanoic acid, 2-phenethyl benzoate, beta-ionone, geranyl acetone, farnesyl acetone and hexahydrofarnesyl acetone etc.	Respiratory diseases preventive, cough suppressant	Asımgil 1997, Yücel (2008), Polat et al. (2015)
Tussilago farfara L.	Kaempferol, glycopyranoside, arabinopyranoside, glycopyranoside, 3-O-α-rhamnopyranosyl (1-6) -β-glycopyranoside, quercetin, rhamnopyranosyl (1-6) -β-glycopyranoside, inulin, phytosterol etc.	Against respiratory diseases, cough, bronchitis and asthma	Yücel (2014), Kökçü et al. (2015)
Urtica dioica L.	Phenolic acids, isoquercitrin, kaempferol, vitamin A-B2-C-K1, histamine, folic acid, lecithin, lignan, polyphenol, sterol, polysaccharide secretin etc.	Asthma preventive	Şimşek et al. (2002), Yücel (2008), Sağıroğlu et al. (2012)
Verbascum bombyciferum Boiss.	Saponins, iridoid, phenylethanoid glycosides, flavonoids, vitamin C, minerals etc.	Bronchitis, tuberculosis prevention	Yücel (2014)
Verbascum olympicum Boiss.	Saponins, iridoid, phenylethanoid glycosides, flavonoids, minerals, mucilage etc.	Asthma ang cough prevention	Yücel (2014), Melikoğlu et al. (2015)
Vitex agnus-castus L.	Flavonoids (casticin, isovitexin, orientin), iridoids (aucubin, agnuside, eurostide), volatile oils, linoleic acid, diterpene, kineol, glycoside, resin etc.	Dyspnea preventive	Daniele et al. (2005), Yücel (2014)
Zingiber officinale Roscoe.	Resin, polyphenols, β carotene, flavonoids, tannins, Fe, Ca, P, Zn, Cu, Cr, Mg, vitamin C, lactone, mucilage, starch, oleoresin, sesquiterpene, etc.	Preventing cold and flu	Yücel (2014), Altay et al. (2015), Karahan and İlçim (2017)

The most commonly used herbs in traditional and complementary medicine against respiratory tract infections are: *Alcea officinalis*, *Lavandula x intermedia*, *Matricaria recutita*, *Mentha x piperita*, *Origanum vulgare*, *Rosmarinus officinalis*, *Salvia officinalis*, *Thymbra spicata*, *Thymus leucostomus*, *Tilia rubra*, *Zingiber officinale*. However, some plants such as *Artemisia annua* L., *Pinus nigra* subsp. *pallasiana*, *Salvia fruticosa*, *Verbascum bombyciferum* have more specific uses such as tuberculosis.

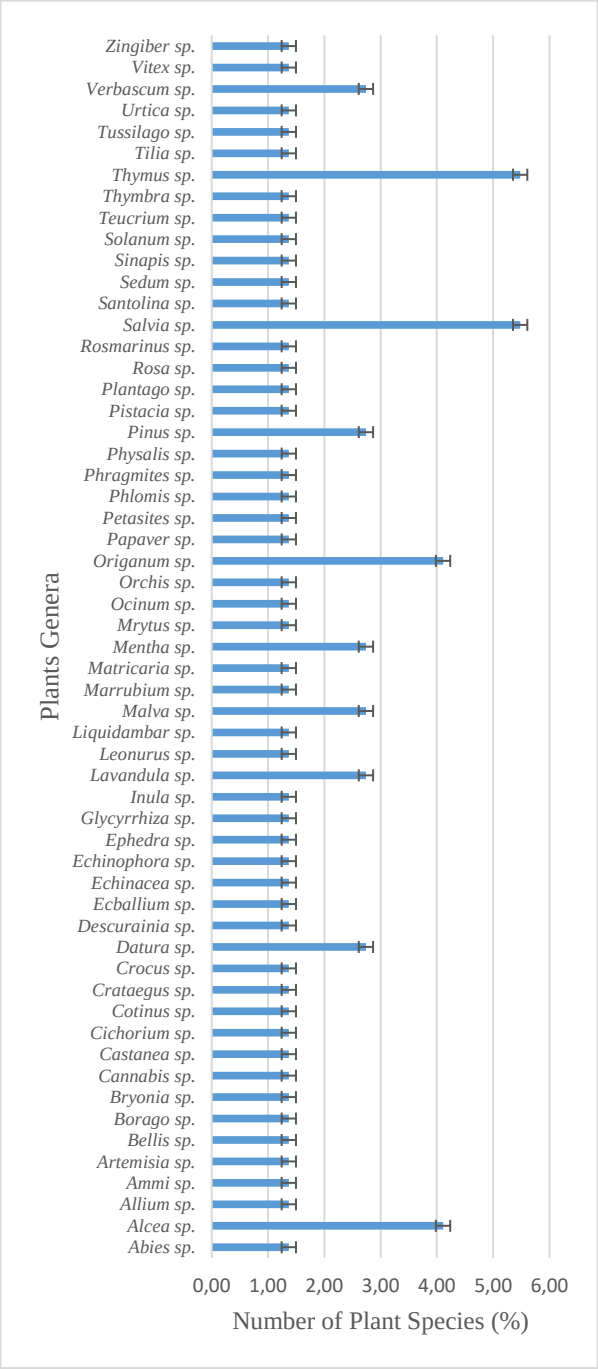

Figure 1. Distribution of plants used in respiratory diseases within the scope of complementary medicine by plant species (%)

In addition to the use of plants one by one, mixtures of various plants are also used. However, although not directly related, some plants such as *Rosa canina* and *Citrus* x *limon* are used in the treatment of respiratory diseases because they are rich in vitamin C.

When examined as a reason for use; These plants are mostly used as cough (22.32%) suppressants, followed by bronchitis (19.64%), asthma (16.96%), cold (12.50%), respiratory tract (12.50%), dyspnea (6.25%), tuberculosis (4.46%), sinusitis (2.68%), flu (1.79%) and expectorant (0.89%) (Fig. 2). Symptoms of respiratory tract diseases are close to each other and the public's lack of knowledge on this issue makes it difficult to define plants by disease type (Table 1). However, specific use is also seen against some diseases such as tuberculosis.

When these plants are examined in terms of traditional usage; *Salvia* sp., *Thymus* sp., *Tilia* sp. as in its types, it is mostly in the form of "herbal teas". In general, the use of dried plant parts is more common. Also, essential oils are used diluted, such as *Lavandula* x *intermedia*. Besides, it is generally used in the form of syrup, or paste prepared by mixing with honey or sugar.

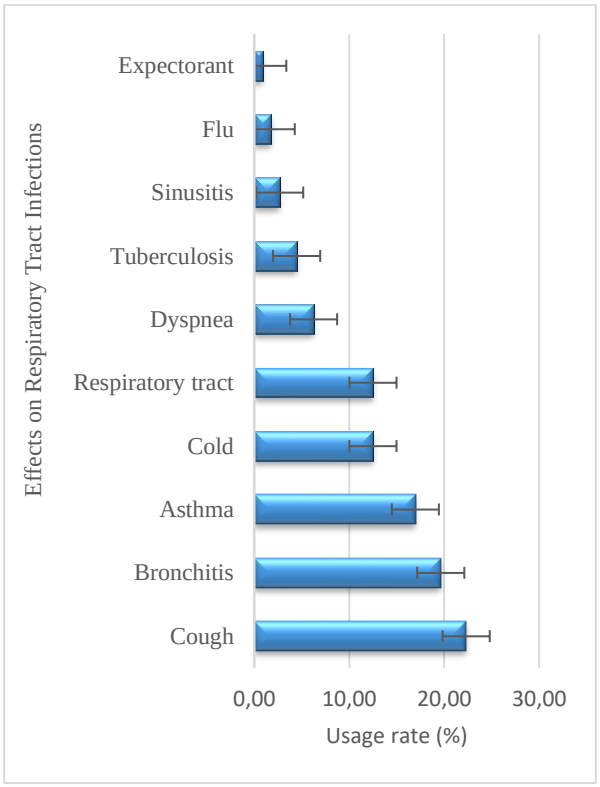

Figure 2. Distribution of plants used in complementary medicine by respiratory tract disease types (%)

The 73 plant species examined in this study contain a large number of secondary metabolites (Table 1). The most common bioactive substances in these plants; tannin (16.79%), terpinen (14.6%), flavonoid (13.87%), glycoside (11.68%) and resin (10.22%) (Fig. 3). These are followed by limonene (9.49%), linalool (8.03%), α-pinene (8.03%), β-pinene (8.03%), borneol (7.3%), camphor (7.3%), mucilage (7.3%), saponin (7.3%), thymol (7.3%), cymene (6.57%), quercetin (6.57%), vitamin c (6.57%), carvacrol (5.84%), p-cymene (5.84%), sabinen (5.84%), 1.8-cineole (5,11%), alkaloid (5.11%), protein (5,11%), coumarin (3.65%), kaempferol (3.65%) and pectin (3.65%), respectively. In addition, there are many bioactive substances such as alkaloids, eugenol, geraniol, inoleic acid, iridoid, luteolin, magnesium, vitamin a, b, asparagine, caryophylene, gallic acid, hyperoside, linoleic acid, myrcene, palmitic acid and others which are found in less

than four percent of the examined plants. The general common feature of these bioactive compounds is their high antimicrobial effect.

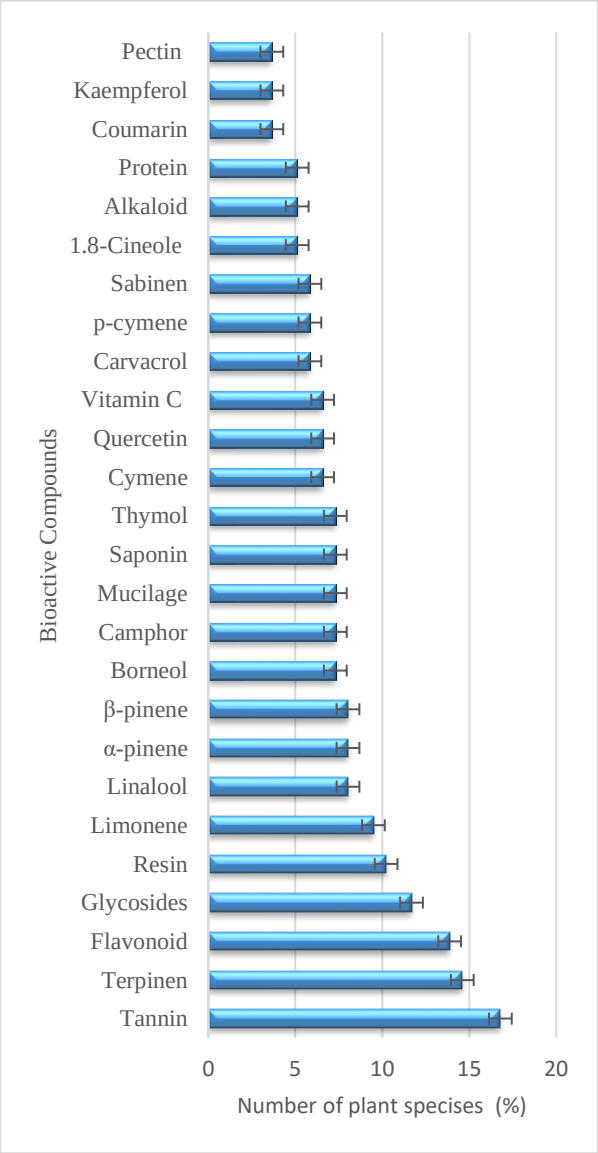

Figure 3. Number of plants containing bioactive substances (for 5 or more plant species)

4. Discussions

Traditional and complementary medicine practices are accepted as an important part of the global health system by World Health Foundation (Biçer and Balçık, 2019). World Health Foundation stated the targets about Traditional Health Strategy at 2002-2005 report, then at 2014-2023 Traditional Health Strategy Report they stated the directions and actions about it. At these reports, it is emphasized that if the traditional and complementary medicine used properly and safely, it can contribute to the modern medicine as well.

The usage of the plants at traditional and complementary medicine practices against the respiratory tract disease can have some important risks. For example, it is stated that the usage of *Echinacea purpurea* at diseases like flu and cold can cause nausea, vomit and effect the coagulation (Cupp, 2000); *Tussilago farfara* ve *Glycyrrhiza glabra* which is used at upper respiratory tract diseases can have side effects like hypertension, headache, arrhythmia and *Pinus silvestris* can cause irritation at skin and mucosa (Öztürk, 2010). Also it is known that some plants can interact with the medicines that are used at respiratory tract infections can interact. For example, *Matricaria recutita* can interact with anticoagulants and iron supplement medication., *Echinacea purpurea* can interact with anabolic steroids, amiodarone, methotrexate, ketoconazole, immunodepressants, corticosteroids and cyclosporin (Erdem and Eren, 2009). Therefore, offering the medicinal plants to consumers with decontaminating them from the risks, at certain standards and by doctors or experts will contribute to solve the problems.

As a result, 73 plants used in respiratory tract diseases were determined (This number is constantly changing with new studies being carried out every day). Some of these herbs are also featured in monographs and pharmacopeia (ESCOP, 1997; WHO, 2006, 2014, 2017; Anton et al., 2009; Demirezer, 2011). The use of herbal drugs in traditional and complementary medicine practices in respiratory tract diseases carries some important risks. Risks such as the lack of reliable scientific studies on this subject and the herb-drug interactions pose a major obstacle. The increasing use of herbal drugs against respiratory tract infections among the public since ancient times necessitates more and more detailed studies on this subject. The literature and field studies conducted during this study show that new bioactive phytochemicals can be obtained from plants to prevent respiratory diseases.

Conflict of Interest

Authors have declared no conflict of interest.

Authors' Contributions

The authors contributed equally.

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