ORIGINAL RESEARCH

Research on Crop Ecophysiology
Vol.14/1, Issue 1 (2019), Pages: 28 - 45

Can Iranian Medicinal Plants Apply to Prevent and Treatment of Viral Diseases?

MOHAMAD HESAM SHAHRAJABIAN[1], WENLI SUN[1], AND QI CHENG[1,2*]
1-Biotechnology Research Institute, Chinese Academy of Agricultural Sciences, Beijing 100081, China
2-College of Life Sciences, Hebei Agricultural University, Baoding, Hebei, 071000, China; Global Alliance of HeBAU-CLS&HeQiS for BioAl-Manufacturing, Baoding, Hebei 071000, China

*Corresponding author E-mail: chengqi@caas.cn; hesamshahrajabian@gmail.com;

Received: 25 September 2018 Accepted: 10 JANUARY 2019

ABSTRACT
Medicinal herbs and plants which have entered the fight against viral diseases because they constitute low-cost and efficient host for biopharmaceutical production. Traditional medicinal plants could likely improve therapeutic outcomes and quality of life, and it is an effective adjuvant in the systemic treatment of viral diseases. Viral infections are spreading rapidly, and emergence of drug resistance due to some mutations of viruses and dormant and recurrent infections may lead to new antiviral combination. Lemon balm (*Melissa officinalis* L.), Hyssop (*Hyssopus officinalis*), Myrtle (*Myrtus communis*), Nut grass (*Cyperus rotundus*), Common fig (*Ficus carica L.*), Clove (*Syzygium aromaticum*), Field elm (*Ulmus minor* Mill.), Persian yellow rose (*Rosa foetida*), Horse mint (*Mentha longifolia*), *Acanthophyllum sordidum*, *Euphorbia bungei*, Leptadenia (*Leptadenia pyrotechnica*), *Linum album*, *Euphorbia helioscopia*, Dog rose (*Rosa canina* L.), Redstem filaree (*Erodium cicutarium*), Common chicory (*Cichorium intybus* L.), Wild rue (*Peganum harmala* L.), Borage (*Echium amoenum*), Greater celandine (*Chelidonium majus*), Rosmary (*Rosmarinus officinalis*), Thymus (*Thymus vulgaris* L.), Sage (*Salvia officinalis*), Mallow (*Malva sylvestris*), Liquorice (Glycyrrhiza glabra), Marjoram (Oriaganum majorana), Anise (Pimpinella anisum L.), Dandelion (*Taraxacum officinale*), Garlic (*Allium sativum*), Basil (*Ocimum basilicum* L.), Fennel (*Foeniculum vulgare*) are native to the Middle East, West and Central of Asia and Iran with anti viral characteristics for future studies. These traditional herbs and plants which have both antiviral activity and ability to promote immunity, would have possible inhibition ability in the initiation and promotion of virus-associated diseases. These important medicinal plants should consider more as a great potential source of novel chemical constituents with anti-viral impacts.

***Keywords**:* Traditional Iranian Medicine, Viral Infection, Medicinal Plants, Natural Products.

INTRODUCTION

Medicinal plants are used in treating diseases because they are low-risk, inexpensive natural materials, readily available, the wide range of both chemical structures and biological activities of natural secondary metabolites the development of recent techniques to accurately detect, isolate, and have a higher consumption by people compared to synthetic drugs (Soleymani and Shahrajabian, 2018; Shahrajabian *et al*., 2019a,b,c; Sun *et al*., 2019a,b;

Khoshkharam *et al*., 2020; Shahrajabian *et al*., 2020a,b,c,d,e; Sun *et al*., 2020a,b). Viral infections are spreading rapidly, and emergence of drug resistance due to some mutations of viruses and dormant and recurrent infections may lead to new antiviral combination. The goal of this review is survey on common medicinal plants in the Middle East, especially Iran with antiviral characteristics.

Medical plants with antiviral acitivites

Lemon balm (*Melissa officinalis* L.) of the Lamiaceae family is an aromatic perennial plant which has been widely used for medicinal purposes (Sentkowska *et al*., 2015; Mokhtarzadeh *et al*., 2017). Its oil major components are geranial, neral, citronella, caryophyllene oxide, geranyl acetate, and β-caryphyllene (Shabby *et al*., 1995; Holla *et al*., 1997; Esmaeili and Rohani, 2012). Taherpour *et al*. (2012) reported (E)-citral, neral and citronellal as the most important compounds in the essential oil of wild *Melissa officinalis* L. in west of Iran. Afsharypuor *et al*. (2015) identified twenty-seven volatile components in the leaf oil, twenty-eight components in the flower oil, and both oils of the leaf and flower were composed of mono- and sesquiterpenoids, and thirty five components in the stem oil which is mainly consisted of the saturated and unsaturated fatty acids as well as some normal saturated hydrocarbons along with minor quantities of volatile terpenoids. Hyssop (*Hyssopus officinalis* L.) belonging to the family Lamiaceae, is an important medicinal and aromatic plant in Iranian fold medicine (Hristova *et al*., 2015; Pirbalouti *et al*., 2019). The major essential oil of *Hyssopus officinalis* are methyl eugenol, limonene, β-pinene, cis-pinocamphone, myrcene, pinocarvone and trans-pine camphone (Figueredo *et al*., 2012; Zawislak, 2016). *Myrtus communis* L. is an evergreen aromatic plant growing wild in Iran (Pezhmanmehr *et al*., 2010; Zomorodian *et al*., 2013). Myrtle is a pleasant annual shrub with dark blue ripe berries with long history of application in pharmaceutical industries, cosmetic, food and perfume (Wannes and Marzouk, 2016). Myrtle (*Myrtus communis* L.) fruit has shown the presence of arabinogalactan, cyclitols, glucose, organic acids, anthocyanins, and oligosaccharides (Chidouh *et al*., 2014). Alipour *et al*. (2014) reported that polyphenols, myrtucommulone, semimyrtucommulone, 1,8-cineole, α-pinene, myrtenyl acetate, limonene, linalool and α-terpinolene are among the most important compounds considered to be the main biologically active compounds. C*yperus rotundus* is a traditional medicinal herb used in the treatment of various diseases (Srivastava *et al*., 2013; Kumar *et al*., 2014). It is a perennial, momocotyledonous and herbaceous plant of the Cyperaceae family. It contains various volatile and non-volatile components including essential oils, alkaloids, flavonoids, terpenoids, chromones, phenylpropanoids, phenolic acids, iridoides, etc (Dhar *et al*., 2017). Aghassi *et al*. (2013) discovered twenty-two compounds from C. rotundus, of which cyperene and cyperotundone were the major components. *Ficus carica* L. (Moraceae) has considered as super food for its medicinal properties since the beginning of history (Barolo *et al*., 2014). Its fruits and leaves present important nutritional components, and numerous bioactive compounds such as phenolic compounds, flavonoids, coumarins, sterols, and volatiles (Trad *et al*., 2014). It has many pharmacological effects, including anti-tumor, antioxidant, the ability to mediate the body metabolism, hyperglycemia, hyperlipidemia, antibiotic, antiviral effects, enhancement of oxidation resistance and activate blood coagulation (Doro *et al*., 2018; Raafat and Wurglics, 2019; Zhang *et al*., 2019). Clove is one of the most popular medicinal and aromatic plants due to its strong bioactivity (Sharma *et al*., 2017; Kaur *et al*., 2019; Kopru *et al*., 2020). It is a tropical evergreen tree of the family Myrtaceae and its small

reddish brown flower buds used as a spice. Eugenol is the main volatile compound extracted oil from clove bud which has been used as a bactericide, fungicide, anesthetic and etc in traditional medicinal science (Yoshimura *et al*., 2011; Bostan *et al*., 2019; Yassin *et al*., 2020), other important components are eugenyl acetate and β-caryophyllene (Koba et al., 2011; Tahir *et al*., 2016). Pino *et al*. (2001) reported that the major components of bud oil were eugenol, β-caryophyllene, and eugenyl acetate, whereas the main constituents in leaf oil contained only eugenol and β-caryophyllene. Its most important pharmaceutical effects are anticancer, antidiabetic, anti-inflammatory, antiviral, antinociceptive, antibacterial, antifungal, antiprotozoal, antioxidant, antithrombotic properties and biological properties. Field elm (*Ulmus minor* Mill.) is a riparian noble hardwood tree and since ancient times they have provided important services to humans (Zebec *et al*., 2016; Martin *et al*., 2019). *Rosa foetida* Herrm., known as Persian yellow rose, Austrian briar, and Austrian copper rose is a species of rose, native to the foothills of Caucasus mountains, and it was introduced from Persia to Europe (Akhoondi *et al*., 2015; Rezghi *et al*., 2015). The major essential oil content of Persian yellow rose is n-nonadecane, 1-heptadecene, and n-dodecanoic acid (Asgarpanah *et al*., 2014).

Mentha longifolia L. is one the most important aromatic and perennial herbs of the Lamiaceae family, having potential sources of essential oils and compounds with interesting pharmacological and therapeutic properties (Murad *et al*., 2016; Moshrefi Araghi *et al*., 2019). The major components of aerial parts of *Mentha longifolia* (L.) are piperitenone oxide, β-caryophyllene, 1,8-cineole, myrcene, limonene, piperitone xoide, germacrene and bicyclogermacrene (Venskutonis, 1996; Nori-Shargh *et al*., 2000). Its essential oil could provide anti-oxidative and anti-genotoxic protection for the oxidative and genotoxic agents (Ceker *et al*., 2013). Jaimand and Rezaee (2002) reported that the major constituents of the leaf oil were piperitone, isomenthone, and *cis*-piperitol, while flower oil contained piperitone, carvone and pulegone. The oil of *M. longifolia* contains high levels of limonene which seems to have imparted bactericidal property to the oil (Rasooli and Rezaei, 2002). It has also anti-inflammatory activity against CLP-induced sepsis possibly through modulating oxidative stress/antioxidant parameters (Rasooli *et al*., 2019). This important herb can be used in treatment of gastrointestinal disorders, respiratory disorders, infectious diseases, with anti-parasitic, anti-microbial, anti-insect, antioxidant, anti-diarrhea, hepatoprotective and spasmolytic effects (Farzaei *et al*., 2017). *Acanthophyllum* is a genus of flowering plant in the family Caryophyllaceae with about 75 species, spread in the Irano-Turanian area (Shamsabad *et al*., 2020). It contains moisture, carbohydrate, protein and ash (Jahanbin *et al*., 2012). Two new gypsogenic acid glycosides, 1 and 2 were isolated from *A. sordidum* and *A. lilacinum*, 2 from *A. elatius* and *A. lilacinum* together with three known saponins, glandulosides B and C and SAPO50 (Timite *et al*., 2010). Euphorbia is one of the largest genus in Euphorbiaceae with more than 2000 species in the world and about 100 species in Iran (Noori et al., 2009). Iran has the largest number of taxa in Southwest Asia with about 90 species including several endemics and species (Pahlevani and Riina, 2014). The most important chemical diversity of Euphorbiaceae family is isoprenoid, and diterpenoids also found in the majority of the genus (Lin *et al*., 2012). The secondary metabolites and extracts from *Euphorbia* plants have been used for treatment of human aliments, such as inflammation, cancer, and microbial infections (Salehi *et al*., 2019). *Euphorbia bungei* Boiss, contains acetone, macrocyclic diterpenoids, and cycloartane triterpenoids (Shokoohinia *et al*., 2011).

Leptadenia pyrotechnica (Forssk.) Decne (Asclepiadaceae) is a famous medicinal shrub, used by herbal practitioners for various ailments such as rhinitis, productive cough, abortion, diabetes, stomach disorders, fever, kidney disorders, stones and cancer (Rasheed *et al*., 2016;

Nair *et al*., 2018). The whole plant afforded 18 new pregnane glycosides with sarcostin, 11-hydroxysarcostin, and deacetyl meta-plexigenin as a glycone moieties and acetyl, benzoyl, cinnamoyl, *p*-coumaroyl, and nicotinoyl ester moieties (Cioffi *et al*., 2006). The genus *Linum* L. (Lineacea) has over 15 species, subspecies or ecotypes in Iran (Sheidai *et al*., 2014). *Linum album* is a herbaceous plant with medical interest due to its content of podophyllotoxin, an aryltetralin lignin with cytotoxic activity (Lalaleo *et al*., 2018a). *Linum* species contain lignans of various chemical structures (von Heimendahl et al., 2005). *Linum album* has been shown to accumulate anti-tumor and anti-cancer podophyllotoxin and its related lignans (Bahabadi *et al*., 2012; Lalaleo *et al*., 2018b). Euphornin is one of the main bioactive constituents with the maximal content of *Euphorbia helioscopia* (Chen *et al*., 2012). Chai *et al*. (2017) considered terpenoid as the most effective medicinal component of *Euphorbia helioscopia* L. Its methanolic extract exhibits the free-radical scavenging activity (Cateni *et al*., 2014), it also possesses significant anthelmintic activity (Lone *et al*., 2012), and can be considered as new lipid lowering agents (Li *et al*., 2018). Geng *et al*. (2015) reported its anti-microbial activity against oral pathogens. As it possesses significant anti-nociceptive, anti-inflammatory and anti-pyretic activities, it can be used for the inhibition synthesis of prostaglandins, and other mediators responsible for pain, inflammation and pyrexia (Saleem *et al*., 2015).

Rose canina belongs to the family of Rosaceae and genus Rosa with about 200 species spread in the temperate zone and subtopics of the Northern hemisphere (Fetni *et al*., 2020). *Rosa canina* contains several compounds including phenolics, terpenoids, galactolipids, carotenoids, fruit acids and factty acid which can be considered responsible for the observed pharmacological and clinical effects (Gruenwald *et al*., 2019). It exhibits numerous biological properties such as antioxidant, anti-cancer, anti-inflammatory, anti-ulcerogenic, anti-obesity, antidiabetic, diuretic, antimutagenic, anticarcinogenic, anti-arthritic, neuroprotective and antimicrobial effects (Kilinc *et al*., 2020; Marmol *et al*., 2020). On the basis of chemical analysis, its extract shows antioxidant activity which may also contribute to the anti-inflammatory effects (Lattanzio *et al*., 2011; Armenteros *et al*., 2013). Biogenic silver nanoparticles with the help of *Rosa canina* plants (Rc-Ag NPs) is highly effective for anti-oxidant, antibacterial, antifungal and DNA cleavage activities (Gulbagca *et al*., 2019). Erodium species has been used in traditional medicines of different countries as a therapeutic agent to treat several diseases such as constipation, dermatological disorders, diabetes, indigestion, urinary inflammations, and as carminative agents with great antiviral, antimicrobial, anti-inflammatory and other health-related activities (Munekata *et al*., 2019). *Erodium cicutarium* is a one- or two-year plant (Lis-Balchin, 1993) which is known for its antihemorrhagic activity, antiviral effect in relation to myxoviruses, Herpes virus type 1, vesicular stomatitis and vaccine virus (Zielinska-Jenczylik *et al*., 1987). The major components in *E. cicutarium* are isomenthone, citronellol, geraniol and methyl eugenol, respectively (Lis-Balchin, 1993). It contained tannin, catechins, gallic and elagic acids, sugars (glucose, galactose, fructose), amino acids (glycine, alanine, proline, histidine, tryptophan, tyrosine, glutamic acid), vitamins K and C. *Erodium circuatrium* has been used for treatment of dysentery, fever, wounds, and worms as traditional medicine; also hepatitis, nephritis, stomach pain, hearth problems, sores and rashes and even as an abortifacient (Tene *et al*., 2007; Molares and Ladio, 2009; Heger *et al*., 2014).

Cichorius intybus L. is a widely distributed, edible, perennial, herbaceous plant known as chicory (Imam *et al*., 2019). In traditional medicine this plant is used as diuretic, anti-inflammatory, digestive, cardiotonic and liver tonic (Satmbekova *et al*., 2018). It is also well known as a coffee substitute and it is also widely used to treat various ailments ranging from

wounds to diabetes (Street *et al*., 2013). Chicory contains cichoriin, esculin, inulin, which may help general health (Nallamilli *et al*., 2013). Its leaves are good sources of phenols, vitamins A and C as well as potassium, calcium and phosphorus which make them important in improving human health (Abbas *et al*., 2015). Bayazid *et al*. (2020) found that the green chicory leaf extract could be used as a natural anti-inflammatory agent. Its main oil components consists of carvacrol, thymol, cinnamic aldehyde, camphor, carvone, linalool, and α-terpineol (Haghi *et al*., 2012). The antimicrobial and antioxidant effectiveness of methanolic extract and different fractions (*n*-butanol, ethyl acetate, chloroform and *n*-hexane) of *C. intybus* seeds are reported (Mehmood *et al*., 2012). Chicory extract rich in natural antioxidants and its root extract regulates the oxidative status and antioxidant gene transcripts in CCl_4-induced hepatotoxicity (El-Sayed *et al*., 2015). *Peganum harmala* (wild rue, Syrian rue, African rue) has been used in traditional medicine of different countries. It is an important perennial herb of the family Zygophyllaceae (Zhang and Chi, 2019). It is mainly distributed in dry areas in the Mediterranean and many Asian countries (Zha *et al*., 2020). The most important chemical compounds of wild rue are harmaline, harmine, harmalol, Harman, and related hallucinogenic alkaloids. *P. harmala* and its active alkaloids possess a wide range of pharmacological activities like cardiovascular, neurologic, anticancer, antidiabetic, antispasmodic, anticholinergic, antihistaminic and antiadrenergic effects (Hamsa and Kuttan, 2011; Azizi *et al*., 2017; Amiri and Fozouni, 2020).

Borage (*Echium amoenum*) is a large, hairy annual herb that is a member of the *Boraginaceae* family. The main compounds determined in flower extract of was Acetic acid, Heptanoic acid, and Propanoic acid (Nadi, 2017; Saadatian *et al*., 2017). The petals of *E. amoenum* have been widely used as sedative, anxiolytic, demulcent, anti-inflammatory, analgesic, antioxidant and tranquilizing effects (Shafaghi *et al*., 2010; Mikaili *et al*., 2012; Beiraghdar *et al*., 2017). *Chelidonium majus* (Papaveraceae) is a famous medicinal herb in Asia, Europe and North of Africa (Pantano *et al*., 2017). *Chelidonium majus* L. contains secondary metabolites, isoquinoline alkaloids such as sanguinarine, chelidonine, chelerythrine, berberine and coptisine, and other compounds unrelated to the alkaloids from the aerial parts are several flavonoids and phenolic acids (Colombo and Bosisio, 1996; Wu *et al*., 2019). The most important pharmacological activities of *C. majus* are anti-inflammatory, antimicrobial, immunomodulatory, anticancer, hepatoprotective and analgesic. *Rosmarinus officinalis* L. (Lamiaceae) is an aromatic plant widely used in traditional medicine as anti-inflammatory, diuretic, antimicrobial, antibacterial and in the prevention and treatment of many other diseases (Chen and Hua, 2019; Karadag *et al*., 2019; Risaliti *et al*., 2019; Perez-Mendoza *et al*., 2019; Ali *et al*., 2020). Phenolic and terpenic compounds are resposnile for main biological activities (Etter, 2005; Lucarini *et al*., 2013; Oliveira *et al*., 2019). The major components of essential oil of *Rosmarinus officinalis* L. are 1,8-cineole, camphor, 1,8-cineole, borneol, α-pinene, and α-terpineol (Boutekedjiret *et al*., 1998; Pino *et al*., 1998; Apostolides *et al*., 2013). The free and boung phenolic compounds of rosmary have antioxidant, antihypertensive and antidiabetic properties (Ladan Moghadam, 2015; Alu/datt *et al*., 2017). *Thymus vulgaris* is a flowering plant of the family Lamiaceae commonly known as thyme, native to Souther Europe, West of Asia and North of Africa and has a world wide distribution (Neves *et al*., 2009; Mahmoodi *et al*., 2019). It is rich in essential oil and contains oxygenated monoterpenes and monoterpene hydrocarbons as its major chemical components, specifically, thymol, carvacrol, *p*-cymene, borneol, trans-caryophyllene, and cis-sabinene hydrate which are the highest concentrations (Perez Lopez *et al*., 2015; Noroozisharaf and Kaviani, 2018). It also contains phenolics reporsented by rosmarinic acid and flavonoids derivatives (Vila, 2002). Thyme is rich in flavonoids act as antioxidants and may improve the immune function

(Dauqan and Abdullah, 2017). Thyme demonstrated significant chemopreventive and therapeutic activities against breast carcinoma (Kubatka *et al*., 2019). *Salvia officinalis* (Sage) is a plant in the family of Lamiaceae which is native to the Middle East and Mediterranean areas (Grzegorczyk *et al*., 2005; Khiya *et al*., 2019). *Salvia officinalis* essential oil was characterized by β-thujone, followed by viridiflorol, camphor, 1,8-cineol, trans-caryophyllene and α-humulene as the major compoenents (Mehalaine *et al*., 2018). Sage contains a wide range of constituents such as alkaloids, carbohydrate, fatty acids, glycosidic derivatives, phenolic compounds, polyacetylenes, steroids, terpenes/terpenoids and waxes (Lima *et al*., 2004; Lima *et al*., 2005; Lima *et al*., 2007a,b; Hayouni *et al*., 2008; El-Hadri *et al*., 2010; Badiee *et al*., 2012; Russo *et al*., 2013). The most important pharmacological properties of sage are anticancer, anti-inflammatory, antinociceptive, antioxidant, antimicrobial, antimutagenic, antidementia, hypoglycemic, and hypolipidemic effecst (Ghorbani and Esmaeilizadeh, 2017). *Malva sylvestris* L. is commonly used as vegetable and a medicinal plant in Iran (Azadpour *et al*., 2016). It is mainly used to treat diseases such as abdominal pain, asthma, colds, digestive and urinary tract infections with reported antioxidant, antibacterial and anti-ulcerogenic properties (Turker and Dalar, 2013; Pinela *et al*., 2016; Moghaddam *et al*., 2020). It can be also considered as an antiseptic, a chemopreventive or a chemotherapeutic agent (Razavi *et al*., 2011). The traditional sources for the use of *Glycyrrhiza* species as an herbal medicine are reported in ancient manuscript from China, Iran, India and Greece (Omer *et al*., 2014). It possesses antibacterial, antioxidant, antimalerial, antispasmodic, anti-inflammatory, and anti hyper glycemic properties. Other important effects are antiulcer, antiviral, antihapatotoxic, antifungal and treatment of herpex simplex (Ashfaq *et al*., 2011; Jalilzadeh-Amin *et al*., 2015; Karahan *et al*., 2016). Glycyrrhizin (GL) and 18*β*-glycyrrhetinic acid (GA) are two main triterpenoids which are responsible for the antiviral activity (Matsumoto *et al*., 2013, Wang *et al*., 2013; Yeh *et al*., 2013; Wang *et al*., 2015). Marjoram (*Origanum majorana* L.) (Family Lamiaceae) is a frost tender perennial undershrub, native to South of Turkey, Cyperus and Mediterranean regions (Prerna and Vasudeva, 2015; Waller *et al*., 2016). Its major compounds are terpinen-4-ol, linalool, and thymol (Pino *et al*., 1997). In folk medicine, it is used to treat asthma, indigestion, cramps, headache, dizziness, depression and rheumatism, and it has diuretic activity (Van Den Broucke and Lemli, 1980; Jun *et al*., 2001). It has shown wide range of pharmacological activites, such as antioxidant, hepatoprotective, cardioprotective, anti-platelet, gastroprotective, antibacterial, and antifungal, antiprotozoal, antiatherosclerosis, anti-inflammatory, antimetastatic, antitumor, antiulcer and anticholinesterase inhibitory activities (Ibanez and Blazquez, 2017; Meabed *et al*., 2018). Anis (*Pimpinella anisum* L.) is an annual aromatic plants which has been used for many centuries in folk medicine (Yazdi *et al*., 2014; Shahamat *et al*., 2016). The most important compounds of aniseeds essential oil are trans-anetole, estragole, γ-hymachalen, paraanisaldehyde and methyl cavicol (Shojaii and Abdollahi Fard, 2012). Dandelion (*Taraxacum officinale* Weber) is a member of the Asteraceae (Compositae) family, and it contains a wide array of phytochemical whose biological activities are actively being explored in various areas of human health (Gonzalez-Catejon *et al*., 2012). Some important health-promotoing benefits of it are anti-rheumatic, anti-inflammatory, anti-carcinogenic and hypoglycaemic activities (Shidoji and Ogawa, 2004; Koh *et al*., 2010; Tettey *et al*., 2014). Garlic has a wide spectrum of actions (*Allium sativum*) such as antibacterial, antioxidant, antiviral, antifungal, antiprotozoal, and beneficial effects on the cardiovascular and immune systems (Klukackova *et al*., 2007; Harris *et al*., 2011; Shang *et al*., 2019). It is also effective in treating of respiratory infectios and triglyceride levels (Zhen *et al*., 2006). It contains abundance chemical compounds such as allicin, alliin, S-allyl

cysteines, thiacremonone, diallyl-disulfide, diallysulfide, and others (Dorrigiv *et al*., 2020). Basil (*Ocimum basilicum*), a member of Lamiaceae family, and its essential oils of basil leaves are composed of phenylpropanoids which are important in treatment of headaches, diarrhea, coughs, warts, worms and kidney malfunctions (Nagi *et al*., 2011). The most important phenylpropanoid compounds contain eugenol, chavicaol, methyl eugenol, methyl chavicol, myristicin, methyl cinnamat and elemicin (Ozcan and Chalchar, 2002). *Foeniculum vulgare* Miller belonging to Umbelliferae (Apiaceae) family, and the volatile oil mainly comprises of five monoterpenes, cumic aldehyde, fenchone, anethole, citronellal and geraniol (Singh *et al*., 2008; Alamer, 2009; Esquivel-Ferrino *et al*., 2012). It has several pharmacological benefits such as anti-inflammatory, antioxidant, antimicrobial, analgesic, carminative, diuretic, and antispasmodic agents (Delaram *et al*., 2011; Jamshidi *et al*., 2012; Burkhardt *et al*., 2015; Abdel-Wahab *et al*., 2017; Akhtar *et al*., 2020; Farid *et al*., 2020). Two different chemotypes, namely methyl chavicol and fenchone are found in the seeds, and the oil from leaves contain methyl chavicol, α-phellandrene, limonene, and fenchone, and the major oil from the stems are (E)-anethole, α-pinene, α-phellandrene, p-cymene, limonene, and fenchone (Garcia-Jimenez *et al*., 2000). Trans-anethole is the major constituent in the leaves of oil (Mojab *et al*., 2007). Major fatty acid compounds of fennel 's fruits are oleic, linoleic, palmitic, myristic and stearic acid (Raouffard and Omidbaigi, 2005).

Acknowledgments
Not applicable.

Authors' Contribution
All authors contributed equally to literature research, writing manuscript, etc.

Funding
This work was supported by the National Key R&D Program of China (Research grant 2019YFA0904700)

Availability of data and materials
Not applicable.

Ethics approval and consent to participate
Not applicable.

Consent for publication
The authors consent for the publication of this review.

Competing interests
The authors declare that they have no potential conflicts of interest.

REFERENCES

Abbas ZK, Saggu S, Sakeran MI, Zidan N, Rehman H, Ansari AA. (2015). Phytochemical, antioxidant and mineral composition of hydroalcoholic extract of chicory (*Cichorium intybus* L.) leaves. Saudi Journal of Biological Sciences, 22, 322-326.

Abdel-Wahab A, Abdel-Razik A-RH, Aziz RLA. (2017). Rescue effects of aqueous seed extracts of *Foeniculum vulgare* and *Carum carvi* against cadmium-induced hepatic, renal and gonadal

damage in female albino rats. Asian Pacific Journal of Tropical Medicine, 10(12), 1123-1133.

Alamer M. (2009). Effect of feeding straw (*Foeniculum vulgare* Mill.) on performance of lactating goats. Journal of Applied Animal Research, 36(1), 61-64.

Afsharypuor S, Alijaniha F, Mosaddegh M, Naseri M, Noorbala A, Fallahi F, Montazeri A. (2012). Essential oil constituents of leaf, flower and stem of *Melissa officialis* L. grown in Gonabad-Kavus (Iran). Journal of Essential Oil Bearing Plants, 18(2), 460-463.

Aghassi A, Naeemy A, Feizbakhsh A. (2013). Chemical composition of the essential oil of *Cyperus rotundus* L. from Iran. Journal of Essential Oil Bearing Plants, 16(3), 382-386.

Akhoondi R, Mirjalili MH, Hadian J. (2015). Quantitative and qualitative variations in the essential oil of *Rosa foetida* Herrm. (Rosaceae) flowers as affected by different drying methods. Journal of Essential Oil Research, 27(5), 421-427.

Akhtar I, Javad S, Ansari M, Ghaffar N, Tariq A. (2020). Process optimization for microwave assisted extraction of *Foeniculum vulgare* Mill using response surface methodology. Journal of King Saud University, 32, 1451-1458.

Ali A, Oon CC, Chua BL, Figiel A, Chong CH, Wojdylo A, Turkiewicz IP, Szumny A, Lyczko J. (2020). Volatile and polyphenol composition, anti-oxidant, anti-diabetic and anti-aging properties, and drying kinetics as affected by convective and hybrid vacuum microwave drying of *Rosamarinus officinalis* L. Industrial Crops and Products, 151, 112463.

Alipour G, Dashti S, Hosseinzadeh H. (2014). Review of pharmacological effects of *Myrtus Communis* L. and its active constituents. Phytotherapy Research, 28(8), 1125-1136.

Alu′datt MH, Rababah T, Alhamad MN, Al-Ghzawi ALA, Ereifej K, Gammoh S, Almajwal A, Hussein NM, Raweshadeh M. (2017). Optimization, characterization and biological properties of phenolic compounds extracted from *Rosmarinus officinalis*. Journal of Essential Oil Research, 29(5), 375-384.

Amiri R, Fozouni L. (2020). Antibacterial effects of *Peganum harmala* seed extracts on drug-resistant clinical isolates of *Acinetobacter baumannii* in North of Iran. Jundishapur J Nat Pharm Prod, 15(2), e92426.

Apostolides NQ, El Beyrouthy M, Dhifi W, Najm S, Cazier F, Najem W, Labaki M, AbouKais A. (2013). Chemical composition of aerial parts of *Rosmarinus officinalis* L. essential oil growing wild in Lebanon. Journal of Essential Oil Bearing Plants, 16(2), 274-282.

Armenteros M, Morcuende D, Ventanas S, Estevez M. (2013). Application of natural antioxidants from strawberry tree (*Arbutus unedo* L.) and dog rose (*Rosa canina* L.) to Frankfurters subjected to refrigerated storage. Journal of Integrative Agriculture, 12(11), 1972-1981.

Ashfaq UA, Masoud MS, Nawaz Z, Riazuddin S. (2011). Glycyrrhizin as antiviral agent against hepatitis C virus. Journal of Translational Medicine, 9, 112.

Asgarpanah J, Ziarati P, Safialdinardebily M. (2014). The volatile oil composition of *Rosa foetida* Herrm. Flowers growing wild in Kurdistan province (Iran). Journal of Essential Oil Bearing Plants, 17(1), 169-172.

Azadpour M, Azadpour N, Bahmani M, Hassanzadazar H, Rafieian-Kopaei M, Naghdi N. (2016). Antimicrobial effect of Ginger (*Zingiber officinale*) and mallow (*Malva sylvestris*) hydroalcholic extracts on four pathogen bacteria. Der Pharmacia Lettre, 8(1), 181-187.

Azizi M, Sedaghat S, Tahvildari K, Derakhshi P, Ghaemi A. (2017). Synthesis of silver nanoparticles using Peganum harmala extract as a green route. Green Chemistry Letter and Reviews, 10(4), 420-427.

Badiee P, Nasirzadeh AR, Motaffaf M. (2012). Comparison of Salvia officinalis L. essential oil and antifungal agents against *candida* species. J Pharm Technol Drug Res, 1, 7.

Bahabadi SE, Sharifi M, Behmanesh M, Safaie N, Murata J, Araki R, Yamagaki T, Satake H. (2012). Time-course changes in fungal elicitor-induced lignin synthesis and expression of the relevant genes in cell cultures of *Linum album*. Journal of Plant Physiology, 169(5), 487-491.

Barolo MI, Mostacero NR, Lopez SN. (2014). *Ficus carica* L. (Moraceae): An ancient source of food and health. Food Chemistry, 164, 119-127.

Bayazid AB, Park SH, Kim JG, Lim BO. (2020). Green chicory leaf extract exerts anti-inflammatory effects through suppressing LPS-induced MAPK/NF-κB activation and hepatoprotective activity in vitro. Food and Agricultural Immunology, 31(1), 513-532.

Beiraghdar F, Einollahi B, Ghadyani A, Panahi Y, Hadjiakhoondi A, Vazirian M, Salarytabar A, Darvishi B. (2017). A two-week, double-blind, placebo-controlled trial of *Viola odorata*, *Echium amoenum* and *Physalis alkekengi* mixture in symptomatic benign prostate hyperplasia (BPH) men. Pharmaceutical Biology, 55(1), 1800-1805.

Bostan M, Radu N, Babeanu N, Zaharie MG, Tanasescu CAH. (2019). Biological properties of a biomaterial obtained from *Syzygium aromaticum*. Molecular Crystals and Liquid Crystals, 695(1), 45-52.

Boutekedjiret C, Bentahar F, Belabbes R, Bessiere JM. (1998). The essential oil from *Rosmarinus officinalis* L. in Algerica. Journal of Essential Oil Research, 10(6), 680-682.

Burkhardt A, Sintim HY, Gawde A, Cantrell CL, Astatkie T, Zheljazkov VD, Schlegel V. (2015). Method for attaining fennel (*Foeniculum vulgare* Mill.) seed oil fractions with different composition and antioxidant capacity. Journal of Applied Research on Medicinal and Aromatic Plants, 2, 87-91.

Cateni F, Zilic J, Altieri T, Zacchigna M, Procida G, Gaggeri R, Rossi D, Collina S. (2014). Lipid metabolites with free-radical scavenging activity from *Euphorbia helioscopia* L. Chemistry and Physics of Lipids, 181, 90-98.

Ceker S, Agar G, Alpsoy L, Nardemir G, Kizil HE, Mete E. (2013). Protective role of *Mentha longifolia* L. ssp. *longifolia* against aflatoxin B. Journal of Essential Oil Bearing Plants, 16(5), 600-607.

Chai J, Wang D, Peng Y, Zhao X, Zhang Q, Li P, Fang X, Wang M, Cai X. (2017). Molecular cloning, expression and immunolocalization analysis of diphosphomevalonate decarboxylase involved in terpenoid biosynthesis from *Euphorbia helioscopia* L. Biotechnology & Biotechnological Equipment, 31(6), 1106-1115.

Chen H, Wang Z, Yang L. (2012). Analysis of euphornin in *Euphorbia helioscopia* L. and its cytotoxicity to mice lung ademocarcinoma cells (LA795). Natural Product Research, 26(22), 2112-2116.

Chen C, Hua W. (2019). The complete chloroplast genome of Rosemary (*Rosmarinus officinalis*). Mitochondrial DNA Part B, 4(1), 147-148.

Chidouh A, Aouadi, S, Heyraud A. (2013). Extraction, fraction and characterization of water-soluble polysaccharide fractions from myrtle (*Myrtus communis* L.) fruit. Food Hydrocolloids, 35, 733-739.

Cioffi G, Sanogo R, Vassallo A, Dal Piaz F, Autore G, Marzocco S, De Tommasi N. (2006). Pregnane glycosides from *Leptadenia pyrotechnica*. J Nat Prod, 69, 625-635.

Colombo ML, Bosisio E. (1996). Pharmacological activities of *Chelidonium majus* L. Pharmacological Research, 33(2), 127-134.

Dauqan EMA, Abdullah A. (2017). Medicinal and functional values of thyme (*Thymus vulgaris* L.) herb. Journal of Applied Biology and Biotechnology, 5(02), 017-022.

Delaram M, Kheiri S, Hodjati MR. (2011). Comparing the effects of echinop hora-platyloba, fennel and placebo on pre-menstrual syndrome. J Reprod Infertil, 12(3), 221-226.

Dhar P, Dhar DG, Rawat AKS, Srivastava S. (2017). Medicinal chemistry and biological potential of *Cyperus rotundus* Linn.: An overview to discover elite chemotype(s) for industrial use. Industrial Crops and Products, 108, 232-247.

Dorra NH, Elbarrawy M, Sallam SM, Mahmoud RS. (2019). Evaluation of antiviral and antioxidant acitivty of selected herbal extracts. Journal of High Institute of Public Health, 49(1), 36-40.

Dorrigiv M, Zareiyan A, Hosseinzadeh H. (2020). Garlic (*Allium sativum*) as an antidote or a protective agent against natural or chemical toxicities: A comprehensive update review. Phytotherapy Research. DOI: 10.1002/ptr.6645

El-Hadri A, del Rio MAG, Sanz J. (2010). Cytotoxic activity of α-humulene and transcaryophyllene from *Salvia officinalis* in animal and human tumor cells. An R Acad Nac Farm, 76, 343-356.

El-Sayed YS, Lebda MA, Hassinin M, Neoman SA. (2015). Chicory (*Cichorium intybus* L.) root extract regulates the oxidative status and antioxidant gene transcripts in CCl_4-induced hepatotoxicity. PLOS ONE, 10(3), e0121549.

Esmaeili A, Rohani S. (2012). The in vitro antioxidative properties and essential oil composition of *Melissa officinalis* L. Journal of Essential Oil Bearing Plants, 15(6), 868-875.

Esquivel-Ferrino PC, Favela-Hernandez JMJ, Garza-Gonzalez E, Waksman N, Rios MY, Camacho-Corona MDR. (2012). Antimycobacterial activity of constituents from *Foeniculum vulgare* var. Dulce grown in Mexico. Molecules, 17, 8471-8482.

Etter SC. (2005). *Rosmarinus officinalis* as an antioxidant. Journal of Herbs, Spices and Medicinal Plants, 11(1-2), 121-159.

Farid A, Kamel D, Montaser SA, Ahmed MM, El-Amir M, El-Amir A. (2020). Assessment of antioxidant, immune enhancement, and antimutagenic efficacy of fennel seed extracts in irradiated human blood cultures. Journal of Radiation Research and Applied Sciences, 13(1), 260-266.

Farzaei MH, Bahramsoltani R, Ghobadi A, Farzaei F, Najafi F. (2017). Pharmacological activity of *Mentha longifolia* and its phytoconstituents. Journal of Traditional Chinese Medicine, 37(5), 710-720.

Fetni S, Bertella N, Ouahab A, Zapater JMM, Fernandez SDP-T. (2020). Composition and biological activity of the Algerian plant *Rosa canina* L. by HPLC-UV-MS. Arabian Journal of Chemistry, 13(1), 1105-1119.

Figueredo G, Ozcan MM, Chalchat JC, Bagci Y, Chalard P. (2012). Chemical composition of essential oil of *Hyssopus officinalis* L. and *Origanum acutidens*. Journal of Essential Oil Bearing Plants, 15(2), 300-306.

Garcia-Jimenez N, Peerez-Alonso MJ, Velasco-Negueruela A. (2000). Chemical composition of fennel oil, *Foeniculum vulgare* Miller, from Spain. Journal of Essential Oil Research, 12(2), 159-162.

Geng D, Yi L-T, Shi Y, Min Z-D. (2015). Structure and antibacterial property of a new diterpenoid from *Euphorbia helioscopia*. Chinese Journal of Natural Medicines, 13(9), 704-706.

Ghorbani A. (2005). Studies on pharmaceutical ethnobotany in the region of Turkmen Sahra, north of Iran (Part 1): General results. J Ethnopharmacol, 102, 58-68.

Gruenwald J, Uebelhack R, More MI. (2019). *Rosa canina*- Rose hip pharmacological ingredients and molecular mechanics counteracting osteoarthritis- A systematic review. Phytomedicine. DOI: 10.1016/j.phymed.2019.152958

Grzegorczyk I, Bilichowski I, Mikiciuk-Olasik E, Wydokinska H. (2005). In vitro cultures of *Salvia Officinalis* L. as a source of antioxidant compounds. Acta Societatis Botanicorum Poloniae, 74(1), 17-21.

Gonzalez-Castejob M, Visioli F, Rodriguez-Casado A. (2012). Diverse biological activities of dandelion. Nutrition Reviews, 70(9), 534-547.

Gulbagca F, Ozdemir S, Gulcan M, Sen F. (2019). Synthesis and characterization of *Rosa canina* medicated biogenic silver nanoparticles for anti-oxidant, antibacterial, antifungal and DNA cleavage activities. Heliyon, 5(12), e02980.

Haghi G, Arshi R, Ghazian F, Hosseini H. (2012). Chemical composition of essential oil of aerial parts of *Cichorium intybus* L. from Iran. Journal of Essential Oil Bearing Plants, 15(2), 213-216.

Hamsa TP, Kuttan G. (2010). Harmine inhibits tumour specific neo-vessel formation by regulation VEGF, MMP, TIMP, and pro-inflammatory mediators both in vivo and in vitro. Eur J Pharmacol, 649, 64-73.

Harris JC, Cottrell S, Plummer S, Lloyd D. (2001). Antimicrobial properties of *Allium sativum* (garlic). Applied Microbiology and Biotechnology, 57, 282-286.

Hayouni EA, Chraief I, Abedrabba M. (2008). Tunisian *Salvia officinalis* L. and *Schinusmolle* L. essential oils: their chemical compositions and their preservative effects against *Salmonella* inoculated in minced beef meat. Int J Food Microbiol, 125, 242-251.

Heger T, Jacobds BS, Latimer AM, Kollmann J, Rice KJ. (2014). Does experience with competition matter? Effects of source competitive environment on mean and plastic trait expression in

Erodium cicutarium. Perspectives in Plant Ecology, Evolution and Systematics, 16(5), 236-246.

Holla M, Svajdlenka E, Tekel J, Vaverkova S, Havranek E. (1997). Composition of the essential oil from *Melissa officinalis* L. cultivated in Slovak Republic. Journal of Essential Oil Research, 9(4), 481-484.

Hristova Y, Wanner J, Jirovetz L, Stappen I, Iliev I, Gochev V. (2015). Chemical composition and antifungal activity of essential oil of *Hyssopus officinalis* L. from Bulgaria against clinical isolated of Candida species. Biotechnology and Biotechnology Equipment, 29(3), 592-601.

Ibanez MD, Blazquez MA. (2017). Herbicidal values of essential oils from oregano-like flavor species. Food and Agricultural Immunology, 28(6), 1168-1180.

Imam KMSU, Xie Y, Liu Y, Wang F, Xin F. (2019). Cytotoxicity of *Chichorium intybus* L. metabolites (Review0. Oncology Reports, 42(6), 2196-2212.

Jahanbin K, Moini S, Gohari AR, Emam-Djomeh Z, Masi P. (2012). Isolation, purification and characterization of a new gum from *Acanthophyllum bracteatum* roots. Food Hydrocolloids, 27(1), 14-21.

Jaimand K, Rezaee MB. (2002). Chemical constituents of essential oils from *Mentha longifolia* (L.) Hudson var. *asiatica* (Boriss.) Rech. F. from Iran. Journal of Essential Oil Research, 14(2), 107-108.

Jalilzadeh-Amin G, Najarnezhad V, Anassori E, Mostafavi M, Keshipour H. (2015). Antiulcer properties of *Glycyrrhiza glabra* L. extract on experimental models of gastric ulcer in mice. Iranian Journal of Pharmaceutical Research, 14(4), 1163-1170.

Jamshidi, E., Ghalavand, A., Sefidkon, F., and Goltaph, E. 2012. Effect of different nutrition systems (organic and chemical) on quantitative and qualitative characteristics of Fennel (*Foeniculum vulgare* Mill.) under water deficit stress. Iran J Med Aromat Plants. 28(2): 309-323.

Jun, W. J., Han, B. K., Yu, K. W., et al. 2001. Antioxidant effects of *Origanum majorana* L. on superoxide anion radicals. Food Chem. 75: 439-444.

Karadag AE, Demirci B, Caskurlu A, Demirci F, Okur ME, Orak D, Sipahi H, Baser KHC. (2019). In vitro antibacterial, antioxidant, anti-inflammatory and analgesic evaluation of Rosmarinus *officinalis* L. flower extract fractions. South African Journal of Botany, 125, 214-220.

Karahan F, Avsar C, Ozyigit II, Berber I. (2016). Antimicrobial and antioxidant activities of medicinal plant *Glycyrrhiza glabra* var. glandulifera from different habitats. Biotechnology & Biotechnological Equipment, 30(4), 797-804.

Kaur K, Kaushal S, Rani R. (2019). Chemical composition, antioxidant and antifungal potential of clove (*Syzygium aromaticum*) essential oil, its major compound and its derivatives. Journal of Essential Oil Bearing Plants, 22(5), 1195-1217.

Khiya Z, Hayani M, Gamar A, Kharchouf S, Amine S, Berrekhis F, Bouzoubae A, Zair T, El-Hilali F. (2019). Valorization of the *Salvia officinalus* L. of the Morocco bioactive extracts: Phytochemistry, antioxidant activity and corrosion inhibition. Journal of King Saud University-Science, 31, 322-335.

Khoshkharam M, Shahrajabian MH, Sun W, Cheng Q. (2020). Sumac (*Rhus coriaria* L.) a spice and medicinal plant- a mini review. Amazonian Journal of Plant Research, 4(2), 517-523.

Kilinc K, Demir S, Turan I, Mentese A, Orem A, Sonmez M, Aliyazivioglu Y. (2020). *Rosa canina* extract has antiproliferative and proapoptotic effects on human lung and prostate cancer cells. Nutrition and Cancer, 72(2), 273-282.

Klukackova J, Navratil M, Duchoslav M. (2007). Natural infection of garlic (*Allium sativum* L.) by viruses in the Czech Republic. Journal of Plant Diseases and Protection, 114, 97-100.

Koba K, Nenonene AY, Raynaud C, Chaumont J-P, Sanda K. (2011). Antibacterial activities of the buds essential oil of *Syzygium aromaticum* (L.) Merr. & Perry from Togo. Journal of Biologically Active Products from Nature, 1(1), 42-51.

Koh Y-J, Cha D-S, Ko J-S, Park H-J, Choi H-E. (2010). Anti-inflammatory effects of *Taraxacum officinale* leaves on lipopolysaccharide-induced inflammatory reslonses in RAW 264.7 cells. Journal of Medicinal Food, 13(4), 870-878.

Kopru S, Say R, Karaman K, Yilmaz MM, Kaplan M. (2020). Optimization of processing parameters for the preparation of clove (*Syzygium aromaticum*) hydroalcoholic extract: A response surface methodology approach to characterize the biofunctional performance. Journal of Applied Research on Medicinal and Aromatic Plants. 16. DOI: 10.1016/j.jarmap.2019.100236

Kubatka P, Uramova S, Kello M, Kajo K, Samec M, Jasek K, Vybohova D, Liskova A, Mojzis J, Adamkov M, Zubor P, Smejkal K, Svajdlenka E, Solar P, Samuel SM, Zulli A, Kassayova M, Lasabova Z, Kwon TK, Pec M, Danko J, Busselberg D. (2019). Anticancer activities of *Thymus vulgaris* L. in experimental breast carcinoma in vivo and in vitro. International Journal of Molecular Sciences, 20, 1749.

Kumar KH, Razack S, Nallamuthu I, Khanum F. (2014). Phytochemical analysis and biological properties of *Cyperus rotundus* L. Industrial Crops and Products, 52, 815-826.

Ladan Moghadam AR. (2015). Antioxidant activity and chemical composition of *Rosmarinus officinalis* L. essential oil from Iran. Journal of Essential Oil Bearing Plants, 18(6), 1490-1494.

Lalaleo L, Alcazar R, Palazon J, Moyano E, Cusido RM, Bonfill M. (2018a). Comparing aryltetralin lignin accumulation patterns in four biotechnological systems of *Linum album*. Journal of Plant Physiology, 228, 197-207.

Lalaleo L, Testillano P, Risueno M-C, Cusido RM, Palazon J, Alcazar R, Bonfill M. (2018b). Effect of in vitro morphogenesis on the production of podophyllotoxin derivatives in callus cultures of *Linum album*. Journal of Plant Physiology, 228, 47-58.

Lattanzio F, Greco E, Carretta D, Cervellati R, Govoni P, Speroni E. (2011). In vivo anti-inflammatory effect of *Rosa canina* L. extract. Journal of Ethnopharmacology, 137(1), 880-885.

Li J, Li H-H, Wang W-Q, Song W-B, Wang Y-P, Xuan L-J. (2018). Jatrophane diterpenoids from *Euphorbia helioscopia* and their lipid-lowering activities. Fitoterapia, 128, 102-111.

Lima CF, Carvalho F, Fernandes E. (2004). Evaluation of toxic/protective effects of the essential oil of *Salvia officinalis* on freshly isolated rat hepatocytes. Toxicol In Vitro, 18, 457-465.

Lima CF, Andrade PB, Seabra RM, Fernandes-Ferreira M, Pereira-Wilson C. (2005). The drinking of a *Salvia officinalis* infusion improves liver antioxidant status in mice and rats. J Ethnopharmacol, 97, 383-389.

Lima CF, Fernandes-Ferreira M, Pereira-Wilson C. (2007a). Drinking of *Salvia officinalis* tea increases CCl_4-induced hepatotoxicity in mice. Food Chem Toxicol, 45, 456-464.

Lima CF, Valentao PCR, Andrade PB, Seabra RM, Fernandes-Ferreira M, Pereira-Wilson C. (2007b). Water and methanolic extracts of Salvia officinalis protect HepG2 cells from *t*-BHP induced oxidative damage. Chem Biol Interact, 167, 107-115.

Lin J, Dou J, Xu J, Aisa HA. (2012). Chemical composition, antimicrobial and antitumor activities of the essential oils and crude extracts of *Euphorbia macrorrhiza*. Molecules, 17, 5030-5039.

Lis-Balchin M. (1993). The essential oils of *Pelargonium grossularioides* and *Erodium cicutarium* (Geraniaceae). Journal of Essential Oil Research, 5(3), 317-318.

Lucarini R, Bernardes WA, Ferreira DS, Tozatti MG, Furtado R, Bastos JK, Pauletti PM, Januario AH, Silva MLA, Cunha WR. (2013). In vivo analgesic and anti-inflammatory activities of *Rosmarinus officinalis* aqueous extracts, rosmarinic acid and its acetyl ester derivative. Pharmacutical Biology, 51(9), 1087-1090.

Mahmoodi M, Ayoobi F, Aghaei A, Rahmani M, Taghipour Z, Hosseini A, Jafarzadeh A, Sankian M. (2019). Beneficial effects of *Thymus vulgaris* extract in experimental autoimmune encephalomyelitis: Clinical, histological and cytokine alternations. Biomedicine & Pharmacotherapy, 109, 2100-2108.

Martin JA, Sobrino-Plata J, Rodriguez-Calcerrada J, Collada C, Gil L. (2019). Breeding and scientific advances in the fight against Dutch elm disease: Will they allow the use of elms in forest restoration? New Forests, 50, 183-215.

Marmol I, Jimenez-Moreno N, Ancin-Azpilicueta C, Osada J, Cerrada E, Rodriguez-Yoldi MJ. (2020). A combination of *Rosa Canina* extracts and gold complex favors apoptosis of Caco-2 cells by increasing oxidative stress and mitochondrial dysfunction. Antioxidants, 9(17).

Matsumoto Y, Matsuura T, Aoyagi H, Matsuda M, Hmwe SS, Date T, et al. (2013). Antiviral activity of glycyrrhizin against hepatitis C virus in vitro. PLOS ONE, 8, e68992.

Meabed EMH, E-Sayed NM, Abou-Sreea AIB, Roby MHH. (2018). Chemical analysis of aqueous extracts of *Origanum majorana* and *Foeniculum vulgare* and their efficacy on *Blastocystis* spp. cysts. Phytomedicine, 43, 158-163.

Mehalaine S, Belfadel O, Menasria T, Messaili A. (2018). Chemical composition and antibacterial activity of essential oils of three medicinal plants from Algerian semi-arid climatic zone. Phytotherapie, 16(S1), S155-S163.

Mehmood N, Zubair M, Rizwan K, Rasool N, Shahid M, Ahmad VU. (2012). Antioxidant, antimicrobial and phytochemical analysis of *Cichorium intybus* seeds extract and various organic fractions. Iranian Journal of Pharmaceutical Research, 11(4), 1145-1151.

Mikaili P, Shayegh J, Asghari MH. (2012). Review on the indigenous use and ethnopharmacology of hot and cold natures of phytomedicines in the Iranian traditional medicine. Asian Pac J Trop Biomed, 22, S1189-S1193.

Moghaddam M, Mehdizadeh L, Sharifi Z. (2020). Macro- and microelement content and health risk assessment of heavy metals in various herbs of Iran. Environmental Sciences and Pollution Research, 27, 12320-12331.

Mokhtarzadeh S, Demirci B, Goger G, Khawar KM, Kirimer N. (2017). Characterization of volatile components in *Melissa officinalis* L. under in vitro conditions. Journal of Essential Oil Research, 29(4), 299-303.

Molares S, Ladio A. (2009). Ethnobotanical review of the Mapuche medicinal flora: use patterns on a regional scale. J Ethnopharmacol, 12(2), 251-260.

Mojab F, Javidnia K, Nickavar B, Yazdani D. (2007). GC-MS analysis of the essential oils of roots and leaves of *Foeniculum vulgare* Mill. Journal of Essential Oil Breaing Plants, 10(1), 36-40.

Moshrefi Araghi A, Nemati H, Azizi M, Moshtaghi N, Shoor M, Hadian J. (2019). Assessment of phytochemical and agromorphological variability among different wild accessions of *Mentha longifolia* L. cultivated in field condition. Industrial Crops and Products, 140. DOI: 10.1016/j.indcrop.2019.111698

Munekata PES, Alcantara C, Collado MC, Garcia-Perez JV, Saraiva JA, Lopes RP, Barba FJ, Silva LDP, SantAna AS, Fierro EM, Lorenzo JM. (2010). Ethnopharmacology, phytochemistry and biological activity of *Erodium* species: A review. Food Research International, 126, 108659.

Murad HAS, Abdallah HM, Ali SS. (2019). *Mentha longifolia* protects against acetic-acid induced colitis in rats. Journal of Ethnopharmacology, 190, 354-361.

Nadi F. (2017). Bioactive compound retention in *Echium amoenum* Fisch. & C. A. Mey. petalis: Effect of fluidized bed drying conditions. International Journal of Food Properties, 20(10), 2249-2260.

Nagai A, Duarte LML, Santos DYAC. (2011). Influence of viral infection on essential oil composition of *Ocimum Basilicum* (Lamaiceae). Nat Prod Commun, 6(8), 1189-1192.

Nair S, Upendra JM, Rao SR, Dagla HR. (2018). Genetic diversity analysis of *Leptadenia pyrotechnica* in Jodhpur region of India. Gene Reports, 10, 157-161.

Nallamilli BR, Kumar ChSP, Reddy KV, Prasanna ML, Maruthi V, Sucharita P. (2013). Hepatoprotective activity of *Cichorium intybus* (Linn.) root extract against carbon tetrachloride induced hepatotoxicity in albino Wistar rats. Drug Invention Today, 5, 311-314.

Neves JD, Pinto E, Amaral MH, Bahia MF. (2009). Antifungal activity of a gel containing *Thymus vulgaris* essential oil against *Candida* species commonly involved in vulvovaginal candidosis. Pharmaceutical Biology, 47(2), 151-153.

Nori-Shargh D, Norouzi-Arasi H, Mohammadi S, Mirza M, Jaimand K. (2000). Volatile components of *Mentha longifolia* (L.) huds. from Iran. Journal of Essential Oil Research, 12(1), 111-112.

Noroozisharaf A, Kaviani M. (2018). Effect of soil application of humic acid on nutrients uptake, essential oil and chemical compositions of garden thyme (*Thymus vulgaris* L.) under greenhouse conditions. Physiol Mol Biol Plants, 24, 423-431.

Noori M, Chehreghani A, Kaveh M. (2009). Flavonoids of 17 species of *Euphorbia* (Euphorbiaceae) in Iran. Toxicological & Environmental Chemistry, 91(4), 631-641.

Oliveira JRD, Camargo SEA, Oliveira LDD. (2019). *Rosmarinus officinalis* L. (rosemary) as therapeutic and prophylactic agent. Journal of Biomedical Sciences, 26(5), 1-22.

Omer MO, AlMalki WH, Shahdi I, Khuram S, Altaf I, Imran S. (2014). Comparative study to evaluate the anti-viral efficacy of *Glycyrrhiza glabra* extract and ribavirin against the Newcastle disease virus. Pharmacognosy Research, 6(1), 6-11.

Ozcan M, Chalchar J-C. (2002). Essential oil composition of *Ocimum basilicum* L. and *Ocimum minimum* L. in Turkey. Czech J Food Sci, 20, 223-228.

Pahlevani AH, Riina R. (2014). Synopsis *Euphorbia* subgen. *Esula sect*. helioscopia (Euphorbiaceae) in Iran with the description of *Euphorbia mazandaranica* sp. nov. Nordic Journal of Botany, 32, 257-278.

Pantano F, Mannocchi G, Marinelli E, Gentili S, Graziano S, Busardo FP, Di Luca NM. (2017). Hepatotoxicity induced by greater celandine (*Chelidonium majus* L.): a review of the literature. European Review for Medical and Pharmacological Sciences, 21(1 Suppl), 46-52.

Perez Lopez LA, de la Torre YC, Cirio AT, de Torres NW, Flores Suarez AE, Aranda RS. (2015). Essential oils from *Zanthoxylum fagara* wild lime, *Ruta chalepensis* L. and Thymus vulgaris l.: Composition and activity against *Aedes aegypti* larvae. Pak. J. Pharm. Sci, 28, 1911-1915.

Perez-Mendosa MB, Llorens-Escobar L, Vanegas-Espinoza PE, Cifuentes A, Ibanez E, Villar-Martinez AAD. (2019). Chemical characterization of leaves and calli extracts of *Rosmarinus officinalis* by UHPLC-MS. DOI: 10.1002/elps.201900152

Pezhmanmehr M, Dastan D, Ebrahimi SN, Hadian J. (2010). Essential oil constituents of leaves and fruits of *Myrtus communis* L. from Iran. Journal of Essential Oil Bearing Plants. 13(1), 123-129.

Pinela J, Baros L, Antonio AL, Carvalho AL, Oliveira AM, Ferreira IC. (2016). Quality control of gamma irradiated dwarf mallow (*Malva neglecta* Wallr.) based on color, organic acids, total phenolics and antioxidant parameters. Molecules, 21(4), 467.

Pino JA, Rosado A, Estarron M, Fuentes V. (1997). Essential oil of Majoram (*Origanum majorana* L.) grown in Cuba. Journal of Essential Oil Research, 9(4), 479-480.

Pino JA, Estarron M, Fuentes V. (1998). Essential oil of rosemary (*Rosmarinus officinalis* L.) from Cuba. Journal of Essential Oil Research, 10(1), 111-112.

Pino JA, Marbot R, Aguero J, Fuentes V. (2001). Essential oil from buds and leaves of clove (*Syzygium aromaticum* (L.) Merr. Et Perry) grown in Cuba. Journal of Essential Oil Research, 278-279.

Pirbalouti AG, Mohamadpoor H, Bajalan I, Malekpoor F. (2019). Chemical compositions and antioxidant activity of essential oils from inflorescences of two landraces of Hyssop [*Hyssopus officinalis* L. subsp. angustifolius (Bieb.)] cultivated in Southwestern, Iran. Journal of Essential Oil Bearing Plants, 22(4), 1074-1081.

Prerna, Vasudeva N. (2015). *Origanum majorana* L.- phyto-pharmacological review. Indian Journal of Natural Products and Resources, 6(4), 261-267.

Raafat K, Wurglics M. (2019). Phytochemical analysis of *Ficus carica* L. active compounds possessing anticonvulsant activity. Journal of Traditional and Complementary Medicine, 9, 263-270.

Raouffard F, Omidbaigi R. (2005). Content and composition of essential and fatty oil of *Foeniculum vulgare* cv. Soroksari cultivated fruits. Journal of Essential Oil Bearing Plants, 8(3), 264-267.

Rasheed HMF, Rasheed F, Qureshi AW, Jabeen Q. (2016). Immunostimulant activities of the aqueous methanolic extract of *Leptadenia pyrotechnica*, a plant from Cholistan desert. Journal of Ethnopharmacology, 186, 244-250.

Rasooli I, Rezaei MB. (2000). Bioactivity and chemical properties of essential oils from *Zararia multiflora* Boiss and *Mentha longifolia* (L.) huds. Journal of Essential Oil Research, 14(2), 141-146.

Rasooli A, Fatemi F, Hajihosseini R, Vaziri A, Akbarzadeh K, Mohammadi Malayeri MR, Dini S, Foroutanrad M. (2019). Synergistic effects of deuterium depleted water and *Mentha*

longifolia L. essential oils on sepsis-induced liver injures through regulation of cyclooxygenase-2. Pharmaceutical Biology, 57(1), 125-132.

Razavi SM, Zarrini G, Molavi G, Ghasemi G. (2011). Bioactivity of *Malva Sylvestris* L., a medicinal plant from Iran. Iranian Journal of Basic Medical Sciences, 14(6), 574-579.

Rezghi M, Hoseinidoust SR, Asgarpanah J. (2015). *Rose foetida* Herrm. Flowers as a future natural antibacterial agent against the main cause of skin burn wound infections, *Pseudomonas aeroginosa*. 5(4), 209-213.

Risaliti L, Kehagia A, Daoultzi E, Lazari D, Bergonzi MC, Vergkizi-Nikolakaki S, Hadjipavlou-Litina D, Bilia AR. (2019). Liposomes loaded with *Salvia triloba* and *Rosmarinus officinalis* essential oils: In vitro assessment of antioxidant, anti-inflammatory and antibacterial activities. Journal of Drug Delivery Sciences and Technology, 51, 493-498.

Russo A, Formisano C, Rigano D. (2013). Chemical composition and anticancer activity of essential oils of Mediterranean sage (*Salvia officinalus* L.) grown in different environmental conditions. Food Chem Toxicol, 55, 42-47.

Saadatian M, Aghaei M, Farahpour M, Aghaei M. (2017). Chemical composition of flowers extract of borage (*Borago officinalis* L.) in wild population from Urmia district, Iran. Journal of Essential Oil Bearing Plants, 20(1), 289-292.

Saleem HN, Batool F, Mansoor HJ, Shahzad-ul-Hussan S, Saeed M. (2019). Inhibition of dengue virus protease by eugeniin, isobiflorin, and biflorin isolated from the flower buds of *Syzygium aromaticum* (cloves). ACS Omega, 4, 1525-1533.

Salehi B, Iriti M, Vitalini S, Antolak H, Pawlikowska E, Kregiel D, Sharifi-Rad J, Oyeleye SI, Ademiluyi AO, Czopek K, Staniak M, Custodio L, Coy-Barrera E, Segura-Carretero A, Cadiz-Gurrea MDIL, Capasso R, Cho WC, Seca AML. (2019). Euphorbia-derived natural products with potential for use in health maintenance. Biomolecules, 9, 337.

Satmbekova D, Srivedavyasasri R, Orazbekov Y, Omarova R, Datkhayev U, Ross SA. (2018). Chemical and biological studies on *Cichorium intybus* L. Natural Product Research, 32(11), 1343-1347.

Sentkowska A, Biesaga M, Pyrzynska K. (2015). Polyphenolic composition and antioxidative properties of Lemon Balm (*Melissa officinalis* L.) extract affected by different brewing processes. International Journal of Food Properties, 18(9), 2009-2014.

Shabby AS, El-Gengaihi S, Khattab M. (1995). Oil of *Melissa officinalis* L., as affected by storage and herb drying. Journal of Essential Oil Research, 7(6), 667-669.

Shafaghi B, Naderi M, Tahmasb L, Kamalinejad M. (2010). Anxiolytic effect of *Echium amoenum* L. in mice. Iran J Pharm Res, 37-41.

Shahamat Z, Abbasi-Maleki S, Mohammadi Motamed S. (2016). Evaluation of antidepressant-like effects of aqueous and ethanolic extracts of *Pimpinella anisum* fruit in mice. Avicenna J Phytomed, 6(3), 322-328.

Shahrajabian MH, Sun W, Cheng Q. (2019a). Clinical aspects and health benefits of ginger (*Zingiber officinale*) in both traditional Chinese medicine and modern industry. Acta Agriculturae Scandinavica, Section B-Soil and Plant Science. DOI: 10.1080/09064710.2019.1606930

Shahrajabian MH, Sun W, Cheng Q. (2019b). A review of astragalus species as foodstuffs, dietary supplements, a traditional Chinese medicine and a part of modern pharmaceutical science. Applied Ecology and Environmental Research, 17(6), 13371-13382.

Shahrajabian MH, Sun W, Zandi P, Cheng Q. (2019c). A review of Chrysanthemum, the eastern queen in traditional Chinese medicine with healing power in modern pharmaceutical sciences. Applied Ecology and Environmental Research, 17(6), 13355-13369.

Shahrajabian MH, Sun W, Shen H, Cheng Q. (2020a). Chinese herbal medicine for SARS and SARS-CoV-2 treatment and prevention, encouraging using herbal medicine for COVID-19 outbreak. Acta Agriculturae Scandinavica, Section B- Soil & Plant Science. DOI: 10.1080/09064710.2020.1763448

Shahrajabian MH, Sun W, Cheng Q. (2020b). Chinese star anise (*Illicium verum*) and pyrethrum (*Chrysanthemum cinerariifolium*) as natural alternatives for organic farming and health care-A review. Australian Journal of Crop Science, 14(03), 517-523.

Shahrajabian MH, Sun W, Cheng Q. (2020c). Product of natural evolution (SARS, MERS and SARS-CoV-2); deadly diseases, from SARS to SARS-CoV-2. Human Vaccinese and Immunotherapeutics. DOI: 10.1080/21645515.2020.1797369

Shahrajabian MH, Sun W, Cheng Q. (2020d). Exploring artemisia annua L., artemisinin and its derivatives, from traditional Chinese wonder medicinal science. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 48(4), 1-23.

Shahrajabian MH, Sun W, Cheng Q. (2020e). Chemical components and pharmacological benefits of basil (*Ocimum basilicum*): a review. International Journal of Food Properties, 23(1), 1961-1970.

Shamsabad MM, Moharrek F, Assadi M, Feliner GN. (2020). Biogeographic history and diversification patterns in the Irano-Turanian genus *Acanthophyllum* s.1. (Caryophyllaceae). Plant Biosystems- An International Journal Dealing with all Aspects of Plant Biology. DOI: 10.1080/11263504.2020.1756974

Shang A, Cao S-Y, Xu X-Y, Gan R-Y, Tang G-Y, Corke H, Mavumengwana V, Li H-B. (2019). Bioactive compounds and biological functions of garlic (*Allium sativum* L.). Foods. 8, 246.

Sharma A, Rajendran S, Srivastava A, Sharma S, Kundu B. (2017). Antifungal activities of selected essential oils against *Fusarium oxysporum* f. sp. lycopersici 1322, with emphasis on *Syzygium aromaticum* essential oil. Journal of Bioscience and Bioengineering, 123(3), 308-313.

Sheidai M, Ziaee S, Farahani F, Talebi S-M, Noormohammadi Z, Farahani YH-A. (2014). Infra-specific genetic and morphological diversity in *Linum album* (Linaceae). Biologia, 69, 32-39.

Shidoji Y, Ogawa H. (2004). Natural occurrence of cancer preventive geranylgeranoic acid in medicinal herbs. The Journal of Lipid Research, 45, 1092-1103.

Shojaii A, Abdollahi Fard M. (2012). Review of pharmacological properties and chemical constituents of *Pimpinella anisum*. ISRN Pharmaceutics, 2012, 510795.

Shokoohinia Y, Chianese G, Zolfaghari B, Sajjadi S-E, Appendino G, Taglialatela-Scafati O. (2011). Macrocyclic diterpenoids from the Iranian plant *Euphorbia bungei* Boiss. Fitoterapia, 82(3), 317-322.

Singh V, Ali M, Katiyar D, Dubey S, Anand D, Malik A. (2008). Volatile constituents and antimicrobial activity of immature green seeds of *Foeniculum vulgare* Miller. Journal of Essential Oil Bearing Plants, 11(6), 655-658.

Soleymani A, Shahrajabian MH. (2018). Changes in germination and seedling growth of different cultivars of cumin to drought stress. Cercetari Agronomice in Moldova, 51(1), 91-100.

Srivastava RK, Singh A, Shukla SV. (2013). Chemical investigation and pharmaceutical action of *Cyperus rotundus*- A review. Journal of Biologically Active Products from Nature, 3(3), 166-172.

Street RA, Sidana J, Prinsloo G. (2013). *Cichorium intybus*: traditional uses, phytochemistry, pharmacology and toxicology. Evidence-Based Complementary and Alternative Medicine. Article ID 579319, 13 pages.

Sun W, Shahrajabian MH, Cheng Q. (2019a). The insight and survey on medicinal properties and nutritive components of shallot. Journal of Medicinal Plant Research, 13(18), 452-457.

Sun W, Shahrajabian MH, Cheng Q. (2019b). Anise (*Pimpinella anisum* l.), a dominant spice and traditional medicinal herb for both food and medicinal purposes. Cogent Biology, 5, 1-25.

Sun W, Shahrajabian MH, Khoshkharam M, Cheng Q. (2020a). Adaptation of acupuncture and traditional Chinese herbal medicines models because of climate change. Journal of Stress Physiology and Biochemistry, 16(1), 85-90.

Sun W, Shahrajabian MH, Huang Q. (2020b). Soybean seeds treated with single walled carbon naotubes (SwCNTs) showed enhanced drought tolerance during germination. International Journal of Advanced Biological and Biomedical Research, 8(1), 9-16.

Taherpour A, Maroofi H, Rafie Z, Larijani K. (2012). Chemical composition analysis of the essential oil of *Melissa officinalis* L. from Kurdistan, Iran by HS/SPME method and calculation of the

biophysicochemical coefficients of the components. Natural Product Research, 26(2), 152-160.

Tahir HU, Sarfraz RA, Ashraf A, Adil S. (2016). Chemical composition and antidiabetic activity of essential oils obtained from two spices (*Syzygium aromaticum* and *Cuminum cyminum*). International Journal of Food Properties, 19(10), 2156-2164.

Tene V, Malagon O, Finzi PV, Vidari G, Armijos C, Zaragoza T. (2007). An ethnobotanical survey of medicinal plants used in Loja and Zamora-Chinchipe, Ecuador. J Ethnopharmacol, 111(1), 63-81.

Tettey CO, Ocloo A, Nagajyothi PC, Lee KD. (2014). Antioxidant activity of solvent fractions of *Taraxacum officinale* (Danelion) leaves. Journal of Herbs, Spices and Medicinal Plants, 20(4), 329-340.

Timite G, Mitaine-Offer A-C, Miyamoto T, Ramezani M, Rustaiyan A, Mirjolet J-F, Duchamp O, Lacaille-Dubois M-A. (2010). Structure elucidation of new oleanane-type glycosides from three species of *Acanthophyllum*. Magnetic Resonance in Chemistry, 48(5), 370-374.

Trad M, Le Bourvellec C, Gaaliche B, Renard CMGC, Mars M. (2014). Nutritional compounds in figs from the Southern Mediterranean region. International Journal of Food Properties, 17(3), 491-499.

Turker M, Dalar A. (2013). In vitro antioxidant and phenolic composition of *M. neglecta* Wallr. (Malvaceae) fruit: A raditional medicinal fruit from Eastern Anatolia. Industrial Crops and Products, 51, 376-380.

Van Den Broucke CO, Lemli JA. (1980). Antispasmodic activity of *Origanum compactum*. Planta Med, 38, 317-331.

Venskutonis PR. (1996). A chemotype of *Mentha longifolia* L. from Lithuania rich in piperitenone oxide. Journal of Essential Oil Research, 8(1), 91-95.

Vila R. (2002). Flavonoids and further polyphenols in the genus Thymus. In Thyme: The Genus Thymus; Stahl-Biskup, E., Saez, F., Ed.; CRC Press: London, UK, 2002; pp. 144-177, ISBN 9780203216859.

Von Heimendahl CBI, Schafer KM, Eklund P, Sjoholm R, Schmidt TJ, Fuss E. (2005). Pinoresinol-lariciresinol reductases with different stereospecificity from *Linum album* and *Linum usitatissimum*. Phytochemistry, 66(11), 1254-1263.

Waller SB, Madrid IM, Ferraz B, Picoli T, Cleff MB, de Faria RO, Meireles MCA, de Mello JRB. (2016). Cytotoxicity and anti-Sporothrix brasiliensis activity of the *Origanum majorana* Linn. oil. Brazilian Journal of Microbiology, 47, 896-901.

Wang JJ, Chen XQ, Wang W, Zhang YT, Yang ZY, Jin Y, et al. (2013). Glycyrrhizic acid as the antiviral component of *Glycyrrhiza uralensis* Fisch. Against coxsackievirus A16 and enterovirus 71 of hand foot and mouth disease. J Ethnopharmacol, 147, 114-121.

Wang L, Yang R, Yuan B, Liu Y, Liu C. (2015). The antiviral and antimicrobial activities of licorice, a widely-used Chinese herb. Acta Pharmaceutica Sinica B, 5(4), 310-315.

Wannes WA, Marzouk B. (2016). Characterization of myrtle seed (*Myrtus communis* var. baetica) as a source of lipids, phenolics, and antioxidant activities. Journal of Food and Drug Analysis, 24, 316-323.

Wu J, He J, Peng L, Wang A, Zhao L. (2019). The complete chloroplast genome sequence of *Chelidonium majus* (Papaveraceae). Mitochondrial DNA Part B, 4(1), 1206-1207.

Yassin MT, Mostafa AA-F, Al-Askar AA. (2020). In vitro anticandidal potency of *Syzygium aromaticum* (clove) extracts against vaginal candidiasis. BMC Complementary Medicine and Therapies, 20, 25.

Yazdai FF, Ghalamkari G, Toghiani M, Modaresi M, Landy N. (2014). Anise seed (*Pimpinella anisum* L.) as an alternative to antibiotic growth promoters on performance, carcass traits and immune responses in broiler chicks. Asian Pacific Journal of Tropical Disese, 4(6), 447-451.

Yeh CF, Wang KC, Chiang LC, Shieh DE, Yeh MH, Chang JS. (2013). Water extract of licorice had anti-viral activity against human respiratory syncytial virus in human respiratory tract cell lines. J Ethnopharmacol, 148, 466-473.

Yoshimura M, Amakura Y, Yoshida T. (2011). Polyphenolic compounds in clove and pimento and their antioxidative activities. Bioscience, Biotechnology and Biochemistry, 75(11), 2207-2212.

Zawislak G. (2016). Essential oil composition of *Hyssopus officinalis* L. grown in Poland. 2016. Journal of Essential Oil Bearing Plants, 19(3), 699-705.

Zebec M, Idzojtic M, Satovic Z, Poljak I, Liber Z. (2016). Alive and kicking, or, living on borrowed time?-Microsatellite diversity in natural populations of the endangered *Ulmus minor* Mill. sensu latissimo from Croatia. Acta Botanica Croatia, 75(1), 53-59.

Zha X, Zhao P, Gao F, Zhou Y. (2020). Complete chloroplast genome sequence of *Peganum harmala*, an important medicinal plant. Mitochondrial DNA Part B, 5(1), 562-653.

Zhang G, Chi X. (2019). The complete chloroplast genome of *Peganum harmala*. Mitochondrial DNA Part B, 4(1), 1784-1785.

Zhang Y, Chen J, Zeng Y, Huang D, Xu Q. (2019). Involvement of AMPK activation in the inhibition of hepatic gluconeogensis by *Ficus carica* leaf extract diabetic mice and HepG2 cells. Biomedicine and Pharmacotherapy, 109, 188-194.

Zhen H, Fang F, Ye DY, Shu SN, Zhou YF, Dong YS, Nie XC, Li C. (2006). Experimental study on the action of allitridin against human cytomegalovirus in vitro: Inhibitroy effects on immediate-early genes. Antiviral Res, 72, 68-74.

Zielinska-Jenczylik J, Sypula A, Budko E, Rzadkowska-Bodalska H. (1987). Interferonogenic and antiviral effect of extracts from *Erodium cicutarium*. Archiv. Immuno. Therapie Experimental, 35, 211-220.

Zomorodian K, Moein M, Goeini Lori Z, Ghasemi Y, Rahimi MJ, Bandegani A, Pakshir K, Bazargani A, Mirzamohammadi S, Abbasi N. (2013). Chemical composition and antimicrobial activities of the essential oil from *Myrtus communis* leaves. Journal of Essential Oil Bearing Plants, 16(1), 76-84.