Review Article
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Antioxidant, antibacterial and therapeutic properties of some endemic medicinal plants of Iran: a review

Abstract

Bioactive compounds of medicinal herbs have possible health benefits with antioxidative, anticarcinogenic, antihypertensive, antimutagenic and antimicrobial activities. Iranian folk medicine is rich of various herbs which have been employed as drug for treatment of various diseases and disorders since ancient times. The present paper provides a brief overview of the medicinal benefits of some important endemic herbal plants of Iran. Studies on these herbs have revealed that they contain powerful active components that might be effective for increasing human health. The main results of the most important recently researches on the medicinal properties of these plants also mentioned in this review paper.

Keywords: herbal plants, iranian flora, antioxidant activity, antimicrobial properties, medicinal benefits

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Abbreviations: ROS, reactive oxygen species; BHA, butylated hydroxy anisole; BHT, butylated hydroxy toluene; TBHQ, tertiary butylated hydroquinon; LDL-C, low density lipoprotein cholesterol; HDL-C, high density lipoprotein cholesterol; DPPH, 2, 2-diphenyl-1-picrylhydrazyl; GC-MS, gas chromatography-mass spectrometry; OHH, obese hyperglycemic hyperlipidemic

Introduction

Lipid oxidation is one of the major causes of quality deterioration and decreasing the shelf life of food products because it leads to color alteration, off-flavor, off-odor and loss of nutrients. It is also related with some diseases such as carcinogenesis, mutagenesis, ageing and arteriosclerosis.[1] Reactive oxygen species (ROS) including superoxide anion radicals (O_2•−), hydroxyl radicals (OH•) and non-free radical species such as hydrogen peroxide (H_2O_2) and singlet oxygen ($^1O_2$) are continuously produced during body's normal metabolism.[2,3] ROS are major causes of oxidation in foods and are also involved in occurrence of diseases such as ageing, cancer, etc.[4] Antioxidant compounds protect the human body from free radicals and ROS effects. They can also provide food protection against oxidative degradation; hence antioxidants increase food quality and acceptability.[5] Various synthetic antioxidants such as butylated hydroxy anisole (BHA) butylated hydroxy toluene (BHT), tertiary butylated hydroquinon (TBHQ) and gallic acid esters are used in the food industry to delay lipid oxidation. However, concerns have been raised about using synthetic antioxidants because of their possible side-effects such as liver damage and carcinogenesis that reported in laboratory animals. For this reason, there is a growing tendency to replace synthetic antioxidants with natural ones.[6]

Recently researchers and food manufacturers have become increasingly interested in plant extracts as natural sources of antioxidants. The antioxidant and antimicrobial properties of various extracts from medicinal plants have been of great interest because of their potential use as natural additives for the prevention of oxidation, controlling pathogens and/or toxin-producing microorganisms in foods.[7] Medicinal plants have been used as traditional medicines all over the world for thousands of years. A report by Gen[8] showed that out of the 104 compounds that are used globally as drugs over 37years, 60 of them originated from Chinese traditional medicinal plants.

Bioactive compounds of medicinal herbs especially polyphenolics have possible health benefits with antioxidative, anticarcinogenic, antihypertensive, antimutagenic and antimicrobial activities.[9] Polyphenols are secondary metabolites of all vascular plants which are distinguished by the presence of several phenol groups (i.e., aromatic rings with hydroxyls) in their structure.[10] They are divided into soluble compounds such as phenolic acids, phenylpropanoids, flavonoids, quinones and non-soluble compounds including condensed tannins and cell wall bound hydroxycinnamic acids. Phenolics possess different biological activities, but most important are antioxidant and antimicrobial activities.[11] Antioxidant activities of polyphenolic compounds is generally due to their redox potential which allow them to have various functions such as hydrogen donors, reducing agents, nascent oxygen quenchers and chelating metal ions in numerous food applications. There are also many other compounds that have functional and nutritional value in edible plants, such as ascorbic acid, nitrogen compounds (amino acids, amines, alkaloids and chlorophyll derivatives) and carotenoids.[12] These compounds play a role as nutrients, bioactive substances, as well as antioxidants. Most natural antioxidants are obtained from plant resources including culinary herbs, spices, fruits, vegetables and oilseed products.[13]

Many previous studies have focused on herbs and spices obtained from and consumed in Europe, Southern Asia and Southeast Asia.[14] This review introduces 8 endemic medicinal plants of Iran that have antioxidant, antimicrobial and therapeutic activities. Functional chemical compounds and also traditional medicinal usage of these herbs among Iranian people were investigated.

Some medicinal plants of Iran

Apiaceae family

***Anethum graveolens* "Shevid":** *Anethum graveolens* L. (Dill), a member of the *Apiaceae* family, is a herbal plant characterized with a single stem and a terminal or primary umbellate flower.[15,16] Dill has been used in various foods such as cans, soups, sauces and also flavoring salads.[17] It is traditionally used in Iran as a treatment for some gastrointestinal ailments such as flatulence, indigestion, stomachache and colic and has also antispasmodic effect on the smooth muscles of the gastrointestinal tract.[18] Hajhashemi et al.,[19] determined hypolipidemic activity of dill powder and its essential oil in male *Wistar* rats fed a high cholesterol diet. Results showed that *A. graveolens* powder (10% w/w) reduced the total cholesterol, low density lipoprotein cholesterol (LDL-C), triglyceride and increased the high density lipoproteincholesterol (HDL-C) concentration. Yazdanparast et al.,[20] also reported decreasing of LDL/HDL ratio in rats which were fed high fat diet after treatment with *A. graveolens* extract for 30days.[20] Shyu et al.,[21] evaluated antioxidant activities of ethanolic extract from dill flower and its various fractions using different methods including 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging, Trolox equivalent antioxidant capacity, reducing power, chelating power and β-carotene bleaching assays. Flower extract had higher antioxidant activity than the leaf and seed extracts in all assays. According to this study, antioxidant activity of flower extract of dill was due to phenols including flavonoids and proanthocyanidins.[21] Singh et al.,[22] studied antioxidant, antifungal and antibacterial activities of essential oil and acetone extract of *A. graveolens*.

According to Gas chromatography-Mass spectrometery (GC-MS) investigation, carvone (55.2%), limonene (16.6%), dill apiole (14.4%), linalool (3.7%), *trans*-dihydrocarvone (2.8%), cis-dihydrocarvone (2.6%), *trans*-isocroweacin (0.8%) was the major components, respectively (Table 1). The extract had excellent antioxidant activity against primary and secondary oxidation products in rapeseed oil and also showed a good antioxidant activity measured by different methods such as thiocyanate method in linoleic acid system, reducing power and scavenging effect on DPPH radical in comparison with BHA and BHT. Antimicrobial analyzes indicated that using inverted Petri plate method, the oil had 100% antifungal activity against *Fusarium graminearum* at 6µL dose.[22] Orhan et al.,[23] determined inhibitory effect of the n-hexane, dichloromethane, ethyl acetate and ethanol extracts from Dill cultivated under organic (AG-O) and conventional (AG-C) conditions against acetylcholinesterase (AChE), butyrylcholinesterase (BChE) and tyrosinase at 200µg/mL. The extracts of AG-O and AG-C screened herein exhibited modest level of BChE-inhibiting properties, while the ethanol extracts had relatively higher antioxidant activity than rest of the extracts.[23] Tian et al.[24] determined in vitro and in vivo antifungal activity of the essential oil extracted from the seeds of dill as a potential food preservative.

This activity was evaluated against *Aspergillus flavus*, *Aspergillus oryzae*, *Aspergillus Niger* and *Alternaria alternate*. The results showed that mycelia growth was noticeably reduced with increasing concentration of dill essential oil while their growth increased with incubation time. The percentages of perished cherry tomatoes were significantly reduced in all treatment groups compared with the control groups and also significantly reduced with increasing concentration of dill oil.[24] Kaur et al.,[25] determined antibacterial activity of aqueous and organic seed extracts of dill. In addition antibacterial effect of these extracts was compared with some standard antibiotics. Hot water and acetone seed extracts were noticeably effective against *E. faecalis*, *S. aureus*, *E. coli*, *P. aeroginosa*, *S. typhimurium* and *S. flexneri* but *Klebsiella pneumoniae* and one strain of *Pseudomonas aeruginosa* were not sensitive to those extracts. Furthermore aqueous and acetone seed extracts were better or similarly active against some of the bacteria in comparison to standard antibiotics.[25] Reports on the side effects of dill are limited. The most common side effect is dermatitis but it is considered very rare and usually only when dealing with large quantities of the live plant outdoors in the presence of ultra-violet light.[26]

In another study Monsefi et al.,[27] determined the effects of dill extracts on the female reproductive system of 54 wistar rats. Results showed a significant increase in the duration of the estrous cycle and in the diestrus phase and the progesterone concentration in high dose extract treatment. These authors suggested that dill can be used either as a regulatory agent of the menstrual cycle for women with irregular cycles or as an antifertility agent.[27]

***Coriandrum sativum* "Geshniz":** *Coriandrum sativum L.* (Coriander) is a culinary and medicinal plant from the *Umbelliferae* family which is used as flavoring agent in food products, perfumes and cosmetics.[28] It is generally cultivated for its seeds. The seeds contain an essential oil and the linalool (monoterpenoid compound), as the main components.[29] Coriander traditionally used in Iran to treat some ailments including dyspeptic complaints, loss of appetite, convulsion, insomnia and anxiety.[30] Aissaoui et al.,[31] determined hypoglycemic and hypolipidemic activities of aqueous extract of *C. sativum*. These activities were evaluated after a single oral dose and after daily dosing for 30 days in normal and obese–hyperglycemic–hyperlipidemic (OHH) *Meriones shawi* rats. A single dose of Coriander extract inhibited hyperglycemia in OHH rats and normo-glycemia was achieved after 6hours of treatment. The extract was not effective on amount of lipids, triglycerides or insulin, but insulin resistance decreased significantly.[31] De Almeida Melo et al.,[32] isolated phenolic compounds of aqueous Coriander extract using gas chromatography and mass spectrometry (GC-MS). Four fractions were recognized from the crude extract and all had caffeic acid in common. Determination of antioxidant activity with β-carotene/linoleic acid model showed that all fractions had similar activity; however, it was less than BHT and the crude aqueous extract.[32] Sreelatha et al.,[33] assessed antioxidant activity of ethanolic-water extract of *C. sativum* on carbon tetrachloried (CCl4) treated oxidative stress in *Wistar* albino rats. They also evaluated the activities of enzymes like alkaline phosphatase, acid phosphatase and protein and bilirubin in serum.

The levels of mentioned enzymes were significantly reduced with increasing concentration of *C. sativum* in a dose-dependent manner. The results indicated that oral administration of the leaf extract at a dose of 200mg/kg body weight significantly reduced the toxic effects of CCl4.[33] In another study Wangensteen et al.,[34] studied antioxidant activity of different solvent extracts from leaves and seeds and oil of C. sativum using different assays such as DPPH scavenging activity, inhibition of 15-lipoxygenase (15-LO) and inhibition of Fe_2^+ induced porcine brain phospholipid peroxidation. Ethyl acetate extracts of both seeds and leaves had highest amounts of phenolic compounds and strongest radical-scavenging activity. In addition leaves extracts were more effective antioxidants than the seeds one. The results of the study indicated that the compounds with medium polarity were the most potential antioxidants.[34] Wong et al.,[35] evaluated antioxidant

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and antibacterial activities of methanolic and water extracts of freeze-dried and irradiated Parsley (*Petroselinum crispum*) and Cilantro (*C. sativum*) leaves and stems. Methanolic extract of parsley had higher total phenolic content and DPPH radical-scavenging activity than cilantro extract. Additionally, methanolic extracts of leaves showed significantly superior radical-scavenging activity, which was related to the total phenolic content. Methanolic stem extracts had greatest bacterial cell damage which led to greater growth inhibition towards *Bacillus subtilis* and *Escherichia coli*.[35] Matasyoh et al.,[36] analyzed the essential oil of leaves of *C. sativum* by GC-Mass and evaluated its antimicrobial activity.

Table 1 Bioactive compounds and health effects of herbal plants of *Apiaceae* family

Herbal plant	Phytochemicals	Potential benefits	References
Anethum graveolens (Dill, shevid)	Carvone, limonene, dill apiole, linalool, trans-dihydrocarvone, cis-dihydrocarvone, trans-isocroweacin	Used as a treatment for some gastrointestinal ailments such as flatulence, indigestion, stomachache and colic and has also antispasmodic effect on the smooth muscles of the gastrointestinal tract.	Hosseinzadeh et al.,[18] Singh et al.[22]
Coriandrum sativum (Geshniz)	2E-decenal, decanal, 2E-decen-1-ol and n-decanol	To treat some ailments including dyspeptic complaints, loss of appetite, convulsion, insomnia and anxiety.	Matasyoh et al.,[36] Emamghoreishi et al.[30]
Cuminum cyminum (Zireye sabz)	γ-terpinene, pinocarveol, 1-methyl-2-(1-methylethyl) benzene, copaene, (5R)-5-methyl-2-(1-methylethylidene) cyclohexanone, carotol, 2-ethylidene-6-methyl-3,5-heptadienal and sabinene	Extensively used as an Iranian traditional medicine for treatment of toothache, diarrhea and epilepsy.	Janahmadi et al.m[42] El-Ghorab et al.[45]

The major constituents were 2E-decenal, decanal, 2E-decen-1-ol and n-decanol. Results showed that the oil has great antimicrobial activity against *K. pneumonia* and *Proteus mirabilis* but the best activity was observed for the Gram positive bacteria.[36] Duarte et al.,[37] determined synergistic antibacterial effect between corianders (*C. sativum*) essential oil and six different antibacterial drugs (*Cefoperazone, Chloramphenicol, Ciprofloxacin, Gentamicin, Tetracycline* and *Piperacillin*). According to their results there was a synergistic action between *Chloramphenicol, Ciprofloxacin, Tetracycline* or *Gentamicin* and the commercial coriander essential oil.[37] Zoubiri et al.,[29] considered the effect of coriander seed essential oil as a fumigant against *Sitophilus granarius* in chickpea grains. They reported that coriander is potentially useful grain protectant with fumigant activity. They concluded that the major compounds from coriander fruit essential oil, mainly linalool, can be developed as a potential fumigant for stored-products protection.[29] Michalczyk et al.,[38] evaluated the effect of adding essential oils of hyssop and coriander at the highest concentration (0.02% v/w) sensorially acceptable to a panel of assessors on the microbiological and biochemical characteristics of stored ground beef. According to GC analysis cis-pinocamphone in essential oil of hyssop and linalool in essential oil of coriander was the main components respectively. Sensory evaluation showed that the addition of coriander in ground beef improved sensory attributes as compared with control sample. The considerable inhibitory effect of both oils addition was observed on *Enterobacteriaceae* family bacteria but they were having minor effects on *lactic acid bacteria*, total viable bacterial count and other groups of microorganisms.[38] Pat et al.,[39] studied the acute toxicity profile of hydro-methanolic extract of Coriander seeds (CS). In this research, mice were once orally administered 1000, 3000 and 5000mg/kg body weight of CS extract. Results showed that CS extract is non-toxic up to 3000mg/kg body weight and LD50 value was more than 5000mg/kg body weight.39

Özbek et al.,[40] determined lethal doses of volatile and fixed oils of several plants including Coriandrum sativum. According to their study LD50 value of essential and free oil extract of coriander were 2.257 and 13.300ml/mg, respectively.[40]

Cuminum cyminum "Zireye sabz": *Cuminum cyminum* is an annual herbaceous plant, belongs to the *Apiaceae* family. Each fruit of this plant contains a green seed with aromatic characteristics. It is used in Iranian folk medicine since more than 200 years ago.[41] The fruits have been extensively used as an Iranian traditional medicine for treatment of toothache, diarrhea and epilepsy.[42] Dhandapani et al.,[43] evaluated the effect of *C. cyminum* seed powder supplementation on the plasma and tissue lipids in *alloxan* diabetic rats. Results showed that oral administration of cumin extract to diabetic rats significantly reduced the blood glucose levels and increased levels of plasma cholesterol, phospholipids, free fatty acids and triglycerides.,[43] Jagtap e al.,[44] studied the effect of methanolic extract of *C. cyminum* seeds on diabetes, oxidative stress and compared it with *Glibenclamide*. They reported that treatment with *C. cyminum* seeds extract and *Glibenclamide* reduced the elevated blood glucose and increased serum insulin and glycogen content. The extract exhibited DPPH and superoxide scavenging activity in a dose dependent manner and the best activity of extract has been shown at concentration of 10–1600lg/ml. In addition half maximal inhibitory concentration (IC_{50}) value of *C. cyminum* seeds extract for inhibition of DPPH and superoxide was found to be 230 and 1120l g/ml respectively.[44]

El-Ghorab et al.,[45] investigated chemical composition and antioxidant activity of ginger (*Zingiber officinale*) and cumin (*C. cyminum*). Cuminal (27.7%), γ-terpinene (23.7%), pinocarveol (11.4%), 1-methyl-2-(1-methylethyl) benzene (7.7%), copaene (6.0%), (5R)-5-methyl-2-(1-methylethylidene) cyclohexanone (5.5%), carotol (4.4%), 2-ethylidene-6-methyl-3,5-heptadienal (2.8%) and sabinene (1.2%) were the major components of cumin essential oil which identified with GC. Cumin had the highest amount

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of volatiles; also highest total phenolic contents were observed in the methanol extract of fresh ginger. According to DPPH assay, maximum antioxidant activity has been shown for cumin essential oil followed by dried ginger essential oil and fresh ginger essential oil.[45] Oroojalian et al.,[46] analyzed essential oils of three *Apiaceae* species, including *Bunium persicum, C. cyminum* and *Carum copticum*, extracted by hydrodistillation, using GC and GC-MS. The main components of *C. cyminum* were cuminaldehyde (30.2%), q-cymene (14.1%), c-terpinene (12.8%), safranal (9.4%) and β-pinene. The *in vitro* antibacterial activities of *B. persicum, C. cyminum* and *C. copticum* essential oils were evaluated against major bacterial food-borne pathogens by using the microdilution method. Results showed that there is a synergistic activity between *B. persicum* and *C. cyminum* against Gram-positive bacteria, including *Staphilococcus aureus, Bacillus cereus* and *Listeria monocytogenes*, compared to use of each essential oil alone.[46] Derakhshan et al.,[47] investigated antibacterial activity of cumin seed essential oil and alcoholic extract against *K. pneumonia* ATCC 13883 and clinical *K. pneumonia* isolates. The essential oil had inhibition zone of 12–16mm/20µL, but the alcoholic extract showed no inhibition zone against any of the *K. pneumonia* strains. Furthermore cumin aldehyde was the major component of the oil determined by GC-MS spectrometry.[47] Table 1 summarizes the bioactive compounds and health effects of some herbs of *Apiaceae* family grown in Iran.

Asteraceae (Compositae)

Cichorium intybus "Kasni": *Cichorium intybus* (Chicory) belongs to the *Compositae* family is called as "Kasni" in Iran. It is used for treatment of acne, inflammation of throat, enlargement of the spleen, diarrhea and vomiting.[48] Chicory has also used as an herbal medicine due to its tonic effects upon the liver and digestive tract.[49] Fresh chicory consists of 68% inulin, 14% sucrose, 5% cellulose, 6% protein, 4% ash and 3% other compounds, whereas dried chicory contains about 98% inulin and 2% other compounds.[50] Ahmed[51] investigated protective effects of *C. intybus* in short and long-term diabetes in albino rat models. Feeding with dried powder of Chicory leaves lowered the blood glucose level to near normal level (85-100mg/dl).[51] Heimler et al.,[52] compared conventionally and biodynamically-grown chicory for its polyphenol content and antiradical activity. Results indicated that total polyphenol content was higher in plants exposed to water stress. Also individual polyphenols including five hydroxycinnamic acids and eight flavonoids (quercetin, kaempferol, luteolin and apigenin glycosides) were identified using HPLC/DAD/MS analysis.[52] Nørbæk et al.,[53] determined anthocyanins of blue perianth segments of *C. intybus* by HPLC. The identified pigments included delphinidin 3,5-di-O-(6-O-malonyl-b-d-glucoside) and delphinidin 3-O-(6-O-malonyl-b-d-glucoside)-5-O-b-d-glucoside and the known compounds were delphinidin 3-O-b-d-glucoside-5-O-(6-O-malonyl-b-d-glucoside) and delphinidin 3,5-di-O-b-d-glucoside.[53] Shaikh et al.,[54] evaluated antimicrobial screening of ethanol, ethyl acetate and aqueous seed extracts of *C. intybus* by agar well diffusion assay against *S. aureus, P. aeruginosa, C. albicans* and *E.coli*. All the extracts exhibited antimicrobial activity against mentioned microorganisms while *S. aureus* was the most sensitive pathogen against aqueous extract and had the widest zone of inhibition.[54]

Lamiaceae

Melissa officinalis "Badranjbooye": *Melissa officinalis* L. is an Iranian medicinal plant locally named Badranjbooye, Varangboo and Faranjmoshk and grows in the north, north-west and western parts of the country.[55] It is traditionally used as a treatment for headaches, flatulence, indigestion, colic, nausea, nervousness, anaemia, vertigo, syncope, malaise, asthma, bronchitis, amenorrhea, cardiac failure, arrhythmias, insomnia, epilepsy, depression, psychosis, hysteria, ulcers and wounds. The leaves of *M. officinalis* L. are also utilized in Iranian traditional medicine as digestive, carminative, antispasmodic, sedative, analgesic, tonic and diuretic as well as for functional gastrointestinal disorders. The analysis of chemical composition of the essential oil of the leaf identified citronellal, citral and β-caryophyllene as major components.[56] Saeb & Gholamrezaee[57] analyzed the essential oil of *M .officinalis* obtained by hydro distillation using GC/MS in three different stages: before flowering stage, flowering stage and after flowering stage. Results showed that the major components before flowering stage were decadienal (29.38%), geraniol (25.3%), caryophyllene oxide (8.75%), geranyl acetate, (5.41%) decadienal (28.04%), geraniol (24.97%), caryophyllene oxide (7.55%) and caryophyllene E (4.65%). Also carvacrol (37.62%), methyl citronellate (32.34%), geranyl acetate (5.82%) and caryophyllene (5.50%) were identified as major components in the flowering stage and after flowering stage of plant.[57]

Lara et al.,[58] investigated antioxidant activity of two natural extracts (*R. officinalis* and *M. officinalis*) in cooked pork patties packed in modified atmosphere packaging (MAP) using TBARS (thiobarbituric acid reactive substances) method and results compared with BHT. It has been shown that lipid oxidation was considerably reduced in samples with added antioxidants compared to control one. According to this study Rosemary extract (Nutrox) was the most potent antioxidant (90.7%) followed by BHT (76.3%) and *lemon balm* extract (Meliox) (74.8%).[58] Hussain et al.,[59] evaluated the antibacterial activity of six *Lamiaceae* essential oils, against pathogenic and food spoilage bacteria (*S.aureus, B.cereus, B.subtilis, Bacillus pumilis, P. aeruginosa, Salmonella Poona (S. Poona*) and *E. coli*) using modified resazurin microtitre-plate assay. According to the results, inhibition zone of *M. officinalis* varied from 13.7 to 28.2mm and also MIC value ranged from 72.0-1000.3mm. GC/MS experiments showed that citronellal (20.5%), β- geraniol (17.0%), β-citronellol (11.5%) were the major components of *M. officinalis*.[59]

Mentha piperita (Na'na): *Mentha piperita* (Peppermint) belongs to the *Lamiaceae* family and is probably originated in Eastern Asia. This medicinal plant is particularly beneficial in building the immune system and fighting secondary infections. *M. piperita* is rich in polyphenolic compounds and therefore has strong antioxidant activity. Menthol is the most abundant constituent of the essential oil which has antibacterial effects.[60] Fadaei et al.,[61] investigated antibacterial activity of essential oil of *M. piperita* against *E.coil, B.subtilis* and *S.typhimurium* using MIC method. Results showed that MIC value of essential oil for these three microorganisms was lower in comparison to this value in Sodium Benzoate. It can be concluded that antimicrobial activity of the essential oil was stronger than Sodium Benzoate.[61] Yadegarinia et al.,[62] investigated antibacterial effect of *M. piperita* oil against *C. albicans* and *E. coli*. Results showed that *M. piperita* oil was active at higher dilutions against mentioned microbial strains. *C.albicans* was the most sensitive microorganism and *E. coli* was the second susceptible microorganism to the essential oil of M. piperita. According to GC/MS results, α-terpinene (19.7%), isomenthone (10.3%), *trans*-carveol (14.5%), pipertitinone oxide (19.3%) and β-caryophyllene (7.6%) were the major compounds.[62] Tyagi et al.,[63] evaluated antimicrobial activity and chemical composition of M.

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piperita oil against food spoilage microorganisms including (*E.coli*, *P. aeruginosa*, *Pseudomonas fluorescens*, *B. subtilis* and *S. aureus*), fungal strains (*Penicillium digitatum, A. flavus, A. niger, Mucor spp* and *F. oxysporum*) and yeasts (*C. albicans* and *Sacchromyces cerevisiae*) by agar dilution method. Results showed that MIC and Minimum bactericidal and fungicidal concentration (MBC/MFC) of *M. piperita* oil ranged from 1.13 to 2.25mg/ml and 2.25 to 9mg/ml for bacterial strains, 1.13 to 2.25mg/ml and 2.25 to 4.5 mg/ml for fungal strains and 1.13mg/ml and 2.25mg/ml for yeasts, respectively. Analysis of chemical composition by GC/MS showed the presence of menthol (19.1%), isomenthone (14.8%), limonene (10.6%), iso-menthanol (8.8%), menthyl acetate (6.6%), β-pinene (5.6%), α-pinene (4.8%), 1,8-cineole (3.5%), isopulegol (3%), pulegone (2.3%), piperitone (2.1%) and β-phellandrene (2.8%) as major components of the oil.[63]

Mentha pulegium "Pooneh": *Mentha pulegium* L. commonly known as pennyroyal is a medicinal plant of *Labiatae (Lamiaceae*) family. The flowering aerial parts of the plant has been conventionally used for its antiseptic properties to treat cold, sinusitis, cholera, food poisoning, bronchitis and tuberculosis and also used as antiflatulent, carminative, expectorant, diuretic, antitussive and menstruate.[64] Kamkar et al.,[65] investigated antioxidative activities of the essential oil, methanol and water extracts of Iranian pennyroyal in vegetable oil during storage. Antioxidant activity of the essential oil and extracts were evaluated using DPPH and β-carotene–linoleic acid methods. According to GC/MS results, pulegone (40.5%), menthone (35.4%) and piperitone (5.2%) were identified as major components and the other compounds were Gamma-sitosterol (2.3%), Benzene, 1-methoxy-4-(2-propenyl) (1.9%), 3-octanol (1.9%), α-amyrin (1.2%), α-pinene (0.9%), α-terpineol (0.9%), β– pinene (0.8%), Germacerene-D (0.6%) and Mint furanone (0.5%).[65] Ait-Ouazzou et al.,[66] evaluated the chemical composition and antimicrobial activity of *M. pulegium, Juniperus phoenicea* and *Cyperus longus* against four gram-positive bacteria including *S. aureus*, *Enterococcus faecium*, *L. monocytogenes* and three Gram negative bacteria including *Salmonella enteritidis*, *E. coli* and *P. aeruginosa*. In determining zone of growth inhibition (mm), *M. pulegium* oil showed the widest antibacterial spectra ranged from 12.6±0.5 mm (*E. coli*) to 35.6±0.6 mm (*L. monocytogenes* EGD-e) depending on the susceptibility of the tested organism. It has been shown that *M. pulegium* had the best bacteriostatic and bactericidal effect between the tested herbal plants as it displayed bacteriostatic activity against all strains tested (with the exception of *P. aeruginosa*) with MIC values of <0.5 (*E. faecium*) and 1µL/mL (*S. aureus*, *L. monocytogenes*, *E. coli* and *S. Enteritidis*). Investigation of MBC showed that *M. pulegium* had antibacterial activity against five of the seven bacteria at concentrations ranged from 0.5µL/mL to10µL/mL. According to GC/MS results, Pulegone (69.8%) was the most abundant compound in *M. pulegium* oil followed by piperitenone (3.1%), Isopulegone (1.8%) and piperitone epoxide cis (1.7%).[66]

Urticaceae

Urtica dioica "Gazaneh": *Urtica dioica* L. (nettle) is an herbaceous perennial flowering plant, belongs to the *Urticaceae* family. Herbal infusion of leaves is used to treat diarrhea, vaginal discharge, internal/external bleeding.[67] In addition leaves have been shown to have hypotensive and anti-inflammatory effects, diuretic and immunomodulatory activity and to alleviate rheumatic pain.[68] Steroids, terpenoids, phenylpropanoids, coumarins, polysaccharides, lectins; and seven flavonol glycosides (kaempherol-3-O-glucoside and -3-O-rutinoside; quercetin-3-Oglucoside and -3-O-rutinoside, isorhamnetin-3-O-glucoside, -3-O-rutinoside and -3-Oneohesperidoside) have been identified as major components of root and flowers of *U .dioica* respectively.[69] Gülçin et al.[70] evaluated antioxidant activity of aqueous extract of nettle. The percentage of inhibition of peroxidation in linoleic acid emulsion and reductive capability of the nettle extract were more than α-tocopherol. In addition, nettle extract in the same concentrations, exhibited more inhibition percentage of superoxide generation than of BHA, BHT and α-tocopherol. DPPH-scavenging activities of the extract and BHA were equal but lower than that of quercetin. The metal chelating ability of the extract was higher than that of BHT, α-tocopherol, or BHA.[70]

Antioxidant activity of hydroalcoholic solution extracts of *U. dioica* and *M. neglecta Wallr* plants and their mixture were investigated. Hydroalcoholic extracts of both plants had strong antioxidant activity, reducing power, superoxide anion radical scavenging, hydrogen peroxide scavenging, free radical scavenging and metal chelating activities in comparison to natural and synthetic standard antioxidants such as BHA, BHT and α-tocopherol. The total antioxidant activity of these two plants was nearly the least while that of the mixture extract was higher than estimated. As a consequence, the antioxidant activity of herbal plants synergistically improves by using their mixture.[71] Antioxidant activity and total phenol content of fifteen different extracts from the leaves of *U. dioica, Pilea microphylla* and *Elatostema umbellatum* were determined. According to the results, butanol and ethyl acetate extracts of *U. dioica* had the highest DPPH radical scavenging activity.[72] Erdogrul[73] evaluated antibacterial activities of ethyl acetate, ethanol, chloroform and acetone extracts of *U. dioica* against some bacterial species including *Bacillus brevis*, *M. luteus*, *Mycobacterium smegmatus*, *E.coli*, *L. monocytogenes* and *S. aureus*, using the agar diffusion method. The results indicated that the all plant extracts of stinging nettle displayed no antibacterial activity against any of the test microorganisms.[73]

Future trends

When consumed consciously and systematically, many herbal plants are very important for human health because of their phenolic compounds. Most medicines are produced synthetically today and many microorganisms can develop resistance very quickly against them, which is not possible in the case of phytochemicals. In recent years, especially in the developed countries, there is a tendency towards increased use of phytochemicals. Medicinal herbs as a source of phytochemicals can help people to stay fit. Healing and nourishing processes may go together. However, endemicity and seasonal or periodical growth of the most of these plants has limited their availability. Accordingly, cultivation, processing and preservation of herbal plants could be a good idea for increasing the availability of endemic plants for all people around the world. The herbs of these plants can also be provided in the form of capsules and powders, as dietary supplements and thus differ from conventional foods or food ingredients. On the other hand, more research into the medicinal effects and health benefits of all the endemic herbal plants in different organs is needed, both from the epidemiological perspective and in animal and cell models. Medicinal benefits and possible harmful effects of the herbal plants should be completely introduced to the consumers.

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Conclusion

Results reported here contribute to the knowledge of antibacterial and therapeutic activities of 8 Iranian medicinal plants. The literature reviews presented in this paper strongly approved the medicinal properties of the all mentioned herbal plants. The finding that these medicinal plants possess antioxidant and therapeutic activity implies that making these plants as an integral part of daily consumption may prevent more diseases. So this review paper could be a useful reference for researchers in this area for increasing their knowledge about Iranian medicinal herbs. Also we hope that our paper will provide a starting point for discovering new plants with better activity than those mentioned here.

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Conflict of interest

The author declares no conflict of interest.

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