10. Antioxidant activity exhibited by medicinal plants, vegetables and fruits from North of Iran

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Abstract. Various side effects of synthetic drugs, has necessitated the move to more natural antioxidants. The demand for highly effective antioxidants having low or no side effects for use in preventive medicine and the food industry is increasing. As plants produce significant amount of secondary methabolites, mostly antioxidant compounds, they are almost replacing the synthetic antioxidants. Plant antioxidants include flavonoids, phenolics and polyphenolics can be used to prevent the oxidative stress caused by reactive oxygen species. Iran is a large country with a wide variety of vegetation and according to tradition some of these are used in folk medicine. The most known application and antioxidant activity of some useful medicinal herbs, fruit and vegetables grown in Northern Iran are introduced in this review.

Abbreviations
BHA: Butylated hydroxyanisole, BHT: Butylated hydroxytoluene, CNS: Central nervous system, FDA: Food and drug administration, GABA: Gamma-amino butyric acid, GC-MS: Gas chromatography mass

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Introduction

A large area of Northern Iran is neighbored by Caspian Sea and the three provinces located in this region are almost covered by Forests. Gilan Province is one of the 31 provinces of Iran. It lies along the Caspian Sea, just west of the province of Mazandaran, east of the province of Ardabil, north of the provinces of Zanjan and Qazvin.

Gilan has a humid subtropical climate with by a large margin of heaviest rainfall in Iran: reaching as high as 1,900 millimetres in the southwestern coast and generally around 1,400 millimetres. Rasht, the capital of the province, is known internationally as the "City of Silver Rains" and within Iran as the "City of Rain". Rainfall is heaviest between September and December because the onshore winds from the Siberian High are strongest, but it occurs throughout the year though least abundantly from April to July. Humidity is very high because of the marshy character of the coastal plains

Figure 1. Deep forests in north part of Iran, Gilan.
and can reach 90 percent in summer for wet bulb temperatures of over 26 °C (79 °F). In May 1990 large parts of the province were destroyed by a huge earthquake, in which about 45,000 people died.

**Medicinal plants of Gilan**

Medicinal plants are various plants used in herbalism and are found to have various medicinal properties. Few plants or their phytochemical constituents have been proven to have medicinal effects by rigorous science or have been approved by regulatory agencies. The type of plant and its medical applications depends on the region they are found and traditional experience introduced by local people.

Based on this type of information, scientists in each part of the world have started investigating their scientific basis of traditions and many plant parts are analyzed, their phytochemicals extracted and introduced to pharmaceutical industries by the present time. However, the dangerous side effects of synthetic drugs, has encouraged the scientist to move to more natural medicines and the research in this area in speedy. A group of useful medicinal herbs, fruit and vegetables are grown wild or planted in province of Gilan (Table 1). These are well known in folk medicine of the region and are mostly used as home remedies. In this review, the most important and known medicinal plants of Gilan will be introduced together with their traditional application. Pharmacology and medicinal properties with emphasize on antioxidant activity will be followed. The oxidation process in any living organism causes production of free radical, if not balanced by their consumption,
Table 1. Selected medicinal plants in North of Iran.

<table>
<thead>
<tr>
<th>No.</th>
<th>Common name</th>
<th>Scientific name</th>
<th>Medicinal properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Berberry</td>
<td><em>Berberis Vulgaris</em></td>
<td>Antioxidant, anti-inflammation</td>
</tr>
<tr>
<td>2</td>
<td>Black Currant</td>
<td><em>Ribes nigrum</em></td>
<td>Antioxidant, anti-inflammation</td>
</tr>
<tr>
<td>3</td>
<td>Cabbage</td>
<td><em>Brassica oleracea</em></td>
<td>Antioxidant</td>
</tr>
<tr>
<td>4</td>
<td>Chamomile</td>
<td><em>Matricaria Recutita</em></td>
<td>Antibacterial, antioxidant</td>
</tr>
<tr>
<td>5</td>
<td>Cherries</td>
<td><em>Prunus avium</em></td>
<td>Antioxidant, anti-inflammation</td>
</tr>
<tr>
<td>6</td>
<td>Clove</td>
<td><em>Syzygium aromaticum</em></td>
<td>Antibacterial, antioxidant</td>
</tr>
<tr>
<td>7</td>
<td>Edible chestnut</td>
<td><em>Castanea sativa</em></td>
<td>Antibacterial, antioxidant</td>
</tr>
<tr>
<td>8</td>
<td>Garlic</td>
<td><em>Allium sativum</em></td>
<td>Antibacterial, antioxidant</td>
</tr>
<tr>
<td>9</td>
<td>Horseradish</td>
<td><em>Armoracia rusticana</em></td>
<td>Antioxidant, antibacterial</td>
</tr>
<tr>
<td>10</td>
<td>Lavender</td>
<td><em>Lavandula stoechas</em></td>
<td>Antioxidant, antibacterial</td>
</tr>
<tr>
<td>11</td>
<td>Lemon</td>
<td><em>Citrus Limon</em></td>
<td>Antioxidant, antibacterial</td>
</tr>
<tr>
<td>12</td>
<td>Lettuce</td>
<td><em>Lactuca sativa</em></td>
<td>Antioxidant, antibacterial</td>
</tr>
<tr>
<td>13</td>
<td>Mint</td>
<td><em>Mentha pulegium</em></td>
<td>Antioxidant, antibacterial</td>
</tr>
<tr>
<td>14</td>
<td>Olive</td>
<td><em>Olea europaea</em></td>
<td>Antioxidant, antibacterial, laxative</td>
</tr>
<tr>
<td>15</td>
<td>Parsley</td>
<td><em>Petroselinum hortense</em></td>
<td>Antioxidant, anti-inflammation, antibacterial, diuretic</td>
</tr>
<tr>
<td>16</td>
<td>Peanut/groundnut</td>
<td><em>Arachis hypogaea</em></td>
<td>Antioxidant, lipid lowering</td>
</tr>
<tr>
<td>17</td>
<td>Persian lime</td>
<td><em>Citrus latifolia</em></td>
<td>Antioxidant, increase immunity</td>
</tr>
<tr>
<td>18</td>
<td>Persian walnut</td>
<td><em>Juglans regia</em></td>
<td>Antioxidant, lipid lowering, laxative</td>
</tr>
<tr>
<td>19</td>
<td>Pomegranate</td>
<td><em>Punica granatum</em></td>
<td>Antioxidant, anti hypertension</td>
</tr>
<tr>
<td>20</td>
<td>Pumpkin</td>
<td><em>Cucurbita pepo</em></td>
<td>Antioxidant, anti-inflammation</td>
</tr>
<tr>
<td>21</td>
<td>Soybean</td>
<td><em>Apios americana</em></td>
<td>Antioxidant, antibacterial</td>
</tr>
<tr>
<td>22</td>
<td>Spinach</td>
<td><em>Spinacia oleracea</em></td>
<td>Antioxidant, increase hemoglobin</td>
</tr>
<tr>
<td>23</td>
<td>Tea</td>
<td><em>Camellia sinensis</em></td>
<td>Antioxidant, anti bacterial, diuretic</td>
</tr>
</tbody>
</table>

Oxidative stress will be occurred. Before starting the type of medicinal plants in north of Iran, a brief review on oxidation and types of antioxidants will be presented.

**Reactive oxygen species (ROS) and antioxidants**

Increased consumption of fruit and vegetables has been associated with protection against various diseases, including cancer and cardiovascular diseases. A diet rich in fruits and vegetables could act against Alzheimer's disease, various cardiovascular pathological conditions and several common cancers. The beneficial effect of most of natural fruits and vegetables is due to the presence of natural antioxidants capable of scavenging ROS. These later are oxygen-containing molecules or atoms that possess an unpaired electron. They are naturally generated during cellular respiration as a by-product. Various external and internal factors could produce free radicals including smoking, air pollution and inflammation. In human and most creatures, the electron transport chain involved in oxidative phosphorylation...
generally fuels energy metabolism efficiently. However, at certain steps, electrons are prematurely leaked to oxygen to produce radicals. The most common radical produced from this type of reactions are superoxide anions. This anion later creates other radicals such as hydrogen peroxide, hydroxyl radical and peroxynitrate as well as non free-radical species such as hydrogen peroxide (H₂O₂) and singlet oxygen (¹⁰O₂) [1]. In Figure 3 various redox reactions leading to the production of ROS are summarized.

ROS are, therefore, continuously produced during normal physiologic events and can easily initiate the peroxidation of membrane lipids, leading to the accumulation of lipid peroxides. ROS are capable of damaging crucial biomolecules such as nucleic acids, lipids, proteins and carbohydrates. It is known that reactive nitrogen species (RNS) as well as ROS could cause DNA damage leading to mutation [2]. The reactive nitrogen species (RNS) include non-radicals (nitrous acid, peroxynitrite, S-nitrosothiol and alkylperoxynitritate) and radical species such as nitric oxide and nitrogen dioxide (Table 2).

![Figure 3. Important redox reactions of free radical generation.](image)

**Table 2.** Mechanism of radical and non-radical ROS and RNS species.

<table>
<thead>
<tr>
<th>Chemical formula</th>
<th>Name</th>
<th>Mechanism of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>O₂⁻</td>
<td>Superoxide anion</td>
<td>Not known, could eliminate eNOS</td>
</tr>
<tr>
<td>H₂O₂</td>
<td>Hydrogen peroxide</td>
<td>Unknown, may activate insulin signaling</td>
</tr>
<tr>
<td>HO⁺</td>
<td>Hydroxyl radical</td>
<td>Unknown</td>
</tr>
<tr>
<td>NO</td>
<td>Nitric oxide</td>
<td>Increases formation of NOS, alters normal cell function</td>
</tr>
<tr>
<td>NO⁻</td>
<td>Nitroxyl</td>
<td>Increases formation of NOS, alters normal cell function</td>
</tr>
<tr>
<td>NO₂</td>
<td>Nitrite</td>
<td>Unknown, methabolite of NO⁻</td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>Nitrate</td>
<td>Unknown, methabolite of</td>
</tr>
<tr>
<td>RSNO</td>
<td>S-nitrosothiol</td>
<td>Unknown, reactive adduct of NOS</td>
</tr>
<tr>
<td>OONO</td>
<td>Peroxynitrile</td>
<td>Not known, may eliminate eNOS</td>
</tr>
</tbody>
</table>
Figure 4 shows how the presence of ROS causes DNA damage, oxidation of protein and peroxidation of lipids. The damage occurred in DNA is then followed by proliferation which ultimately leads to tumor formation (Figure 5).

It has been demonstrated that ROS interact with biological systems increasing the risk of cellular injury and aging [4], prostate and colon cancers and coronary heart disease [5], hypertension and AIDS [6].

Figure 4. Formation of free radicals and their damage to biological molecules.

Figure 5. DNA damage by ROS leading to carcinogenesis [3].

**Antioxidants and their mechanism of action**

The harmful action of ROS and free radicals is normally blocked by antioxidant substances, which scavenge the free radicals and detoxify the organism [7]. Antioxidants are compounds that can delay or inhibit the oxidation of lipid or other molecules by inhibiting the initiation or propagation of oxidizing chain reactions [9]. All aerobic organisms have antioxidant defense systems [9]. These systems are able to scavenge free
radicals and increase shelf life of processes foods by retarding the process of lipid peroxidation, the major cause of food and pharmaceutical deterioration [10]. Antioxidants can protect the human body from free radicals and ROS effects. They retard the progress of many chronic diseases as well as lipid peroxidation [11].

Being enzymatic or non enzymatic species, antioxidant molecules are classified in different categories (Table 3). Both enzymatic (superoxide dismutase and catalase) and non-enzymatic (antocyanins and tochopherols) antioxidants are able to turn ROS into stable, harmless molecules. They are used in various applications such as pharmaceutical, food, cosmetic, and chemical industries in order to act as preservative and extend efficiency and economical value of the products.

Considering that antioxidant capacity of an organism is limited, excess production of various oxidizing compounds produces a condition called oxidative stress. Oxidative stress contributes to the pathogenesis of various diseases (e.g. cancers, neurodegenerative disorders and diabetes). Defense against oxidative stress through production of antioxidants and repair processes may constitute important allocations to somatic effort, and is particularly relevant for species with low extrinsic mortality.

Antioxidants are major compounds that protect the quality of life by retarding the oxidation process through scavenging free radical produced during many natural events. Although their ultimate aim is removal of ROS, they may use different mechanism depending on their structure and site of

<table>
<thead>
<tr>
<th>Name</th>
<th>Categories of antioxidants</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antioxidant C</td>
<td>Carotenoids</td>
<td>β-carotene, Lycopene, Lutein</td>
</tr>
<tr>
<td>Antioxidant E</td>
<td>Enzymes</td>
<td>Superoxide dismutase (SOD), Catalase, GPx</td>
</tr>
<tr>
<td>Antioxidant G</td>
<td>Glutathione</td>
<td>Glutathione</td>
</tr>
<tr>
<td>Antioxidant H</td>
<td>Hormones</td>
<td>Melatonin, Oestrogen</td>
</tr>
<tr>
<td>Antioxidant L</td>
<td>Lipid associated chemicals</td>
<td>Ubiquinol-10, N-acetyl cysteine, lipoic acid</td>
</tr>
<tr>
<td>Antioxidant M</td>
<td>Minerals</td>
<td>Zinc, Selenium, Copper</td>
</tr>
<tr>
<td>Antioxidant P</td>
<td>Phenolics</td>
<td>Quercetin, Catechin</td>
</tr>
<tr>
<td>Antioxidant S</td>
<td>Saponines, Steroids</td>
<td>Cortisone, Estradiol, Estriol</td>
</tr>
<tr>
<td>Antioxidant V</td>
<td>Vitamins</td>
<td>α-tocopherol, Ascorbic acid</td>
</tr>
</tbody>
</table>
Antioxidants are also able to act by up-regulating the expression of the genes encoding the antioxidant enzymes, repairing oxidative damage caused by radicals and increasing elimination of damaged molecules [12].

The use of antioxidants in food industry is inevitable as they can increase shelf life and prevent oxidation. Synthetic antioxidants such as butylated hydroxytoluene (BHT), sodium benzoate and butylated hydroxyanisole (BHA) are widely used in food products. However, their use must be controlled due to possible hazards such as carcinogenicity and toxicity [18]. Phenolic compounds from plant sources may act as antioxidants by scavenging lipid radicals.

Over the last few years, an increasing interest in the search for naturally occurring antioxidants is ongoing. A large number of plants including fruits and vegetables are known as rich sources of antioxidant. The type of plant and its antioxidant activity depends entirely to the region that plant grows and natural vegetation present.

**Table 4.** Mechanism of action for various natural antioxidants.

<table>
<thead>
<tr>
<th>Antioxidant</th>
<th>Disorder caused</th>
<th>Mechanism of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaloids</td>
<td>Cancer, Neurodegenerative diseases, chronic inflammation</td>
<td>A variety of biological activities such as topoisomerase I and II, cytotoxicity against different tumor cell lines [13]</td>
</tr>
<tr>
<td>Chatechins</td>
<td>Neurodegenerative disease</td>
<td>Enhances activity of SOD and catalase [14]</td>
</tr>
<tr>
<td>Cartenoids</td>
<td>Cancer, diabetic retinopathy, chronic inflammation</td>
<td>Acts as physical quencher of ROS [12]</td>
</tr>
<tr>
<td>α-tocopherol</td>
<td>Cancer, Neurodegenerative diseases, chronic inflammation</td>
<td>Scavenger of lipid peroxy radicals [15]</td>
</tr>
<tr>
<td>Phenolics</td>
<td>Cancer, diabetic retinopathy, chronic inflammation</td>
<td>Inhibitor for oxidation of lipids and proteins [16]</td>
</tr>
<tr>
<td>Tannins</td>
<td>Cardiovascular disease</td>
<td>Enhance synthesis of nitric oxide and relax vascular segments precontracted with norepinephrine [17]</td>
</tr>
</tbody>
</table>

**Antioxidant properties of Gilan medicinal plants**

In this section some of the most known, used and important medicinal fruits, vegetables and herbs from Province of Gilan are first introduced. A
literature review on their medicinal properties with emphasize to antioxidant properties will then follow. The order they appear in the review is alphabetic rather than importance or special properties.

**Barberry**

Barberry (*Berberis Vulgaris*) is a thorny shrub with yellow flowers, small red fruits and leaves which are narrow at the base and narrow and serrated on the edges. It's a decorative herb through its nicely colored flowers and fruits which last throughout the year including winter time. There are a considerable number of active chemical substances. The bark contains a large number of isoquinoline alkaloids (berberine, berbamine, oxyacantha) and tanines [19]. Barberry fruits contain glucose, fructose, malic acid, pectine, vitamin C. Due to the presence of tannin, vitamin C, and potassium salts, barberry is effective as antioxidant, diuretic, anti-sclerotic, hypotensive, and anti-rheumatic fruit. Its leaves possess great diuretic and anti-rheumatic effects, favoring the elimination of uric acids.

In Iranian folk medicine, barberry is known as anti-bacterial, antiaging (antioxidant) and anti-fungal properties. *Berberis vulgaris* L. fruits are used for ailments and discomforts of kidneys, urinary and gastrointestinal tract, for liver diseases, bronchial discomforts, and as a stimulant for the circulatory system. It has been reported that extracts from root of *Berberis vulgaris* could show antimicrobial activity against *Bacillus subtilis* NCTC 8236, *Staphylococcus aureus* ATCC 6538, *Escherichia coli* ATCC 10535, *Pseudomonas aeruginosa* ATCC 27853 and *Candida albicans* ATCC 10231 [20]. The leaf extracts and fruits of *Berberis Vulgaris* have been shown to be active antioxidants for prevention of lipid peroxidation and protection from DNA damage [21].

**Cabbage**

Cabbage (*Brassica oleracea*) is a leafy green vegetable being a biennial, flowering plant with a short stem and a mass of green, red or purple leaves. Cabbage is a rich source of carbohydrates, mineral salts, vitamin C and provitamine A and antioxidants from carotenoid family. Cabbage has been valued for medicinal purposes in treating headaches, gout, diarrhea and peptic ulcers since long time ago [22]. In general, *Brassica* vegetables, including cabbages, have been reported to contain high amount of dietary fibre and various bioactive agents with high antioxidant activity. It has been found that most of beneficial effects of cabbage is related to phytochemicals, particularly its indole-3-carbinole (I3C), sulforaphane and indoles acting
through antioxidant and detoxification mechanisms that dismantle and eliminate cancer-producing substances [23]. The cooked, fresh or pickled forms of cabbage are used as a food or salad ingredient.

In Iranian traditional medications, this beneficial vegetable is used as a powerful diuretic for edema, kidney stones, cirrhosis and ascites. The most important antioxidant compounds found in various forms of cabbage include vitamin C, α-tocopherol and a range of phenolic compounds. It has been found that antioxidant activity of red cabbage is higher than white cabbage indicating that antocyannines of pigments in red forms significantly contribute to antioxidant properties of the plant. Short and prolonged heat treatment as well as fermentation process could significantly improve the antioxidant properties of cabbage.

**Chamomile**

Chamomile (*Matricaria recutita* L.) belonging to the Asteraceae family, is a well-known medicinal plant species from the Asteraceae family. It is one of the most common medicinal plants, found in the pharmacopoeias of 26 countries. The plant is grown widely and extensively in Northern parts of Iran. Its flowers bloom from May until late August or early September with pleasant aroma and flavor. In Iranian folk medicine, chamomile is used to control neuralgia and rhomathoid arteritis. Chamomile flowers contain many beneficial compounds including etheric oil, vitamins B1 and C, minerals, (phosphorus, potassium, silicon, iron, manganese, calcium, copper, lead, zinc, zirconium), carbohydrates and trace amounts of lipids. Due to its antibacterial properties it has many applications in cosmetic preparations. The extracts of chamomile flowers are potential sources of up to 32 sesquiterpenic, mostly act as antioxidant compounds [24]. These compounds are mostly responsible for health benefits of medicinal plants and fruits [25]. Most of antioxidant activity of plants is related to their polyphenol contents. It has been reported that chamomile is quite reach in polyphenols.

**Cherries**

Sour cherriy (*Prunus cerasus* L.) is a favorite fruit of northern part of Iran, especially in Gilan province. Having 70% water content, cherries possess a powerful detoxifying and depurative action suitable for patients suffering from rheumatoid arthritis, gout or constipation. They are also rich sources of B complex and C vitamins B1, B2, B6. From the age of 40, some individuals may suffer from acidosis and alkalosis, responsible for an early aging; in its action of rebalancing the pH of the blood, the cherry diminishes
these disorders. The main sugar is laevulose, perfectly assimilated by diabetics. Cherry juice causes the elimination of food debris and toxins from the body. People suffering from rheumatism, those suffering from gout and arthritis should drink it. Cherry juice cleans the urinary tract and intestines. Cherry tails and leaves have medicinal properties recommended in urinary tract diseases. Besides their anti-inflammatory qualities, they are famous for their diuretic action.

A variety of research has indicated that sour cherries are rich in phenolic compounds [26]. Sour cherries contain significant levels of anthocyanins with potent antioxidant and anti-inflammatory activities [27]. Inhibition of cyclooxygenases activity has been reported by water extracts of sour cherry [27]). On the other hand, the presence of anthocyanins in sour cherry could increase activity of superoxide dismutase and decrease the level of tumor necrosis factor-α, interleukin-6 and malondialdehyde (MDA) in serum [28].

In Iranian tradition, the juice or drinks made of sour cherry are very common and delicate, especially in summer. It has been reported that a glass of sour cherry juice daily could increase total antioxidants in people addicted to smoking cigarettes and, therefore, reduce the adverse effect of ROS produced by cigarette smoke [29].

**Clove**

Clove (Syzygium aromaticum) are the aromatic dried flower buds of a tree in the family Myrtaceae. Being native to the Maluku islands in Indonesia, cloves are also found and harvested in Indonesia, India, Iran and Pakistan. The clove tree is an evergreen plant that grows to a height of 8–12 m, having large leaves and sanguine flowers in numerous groups of terminal clusters. The buds are pale turning green gradually which develop into a bright red, when they are ready for collecting. Cloves are harvested when 1.5–2 cm long, and consist of a long calyx, terminating in four spreading sepals, and four unopened petals which form a small ball in the center.

Clove are also used as painkiller for dental emergencies in Iranian folk medicine. The essential oil of the plant is used in aromatherapy when stimulation and warming are needed, especially for digestive problems. Within Iran, the plant is found in Northern parts of the country and is a popular medicinal plant used by natives. According to scientific literature, *Syzygium aromaticum* is well known as antimicrobial agent against oral bacteria [30]. It has been shown that *Syzygium aromaticum* could successfully be used for asthma and various allergic disorders by oral administration [31]. In addition, the cloves are widely used traditional
medicine for treatment many diseases such as disorder of digestive systems [32], bacterial and fungal infections and toothaches [33]. Sesquiterpenes, found in clove, were investigated as potential anticarcinogenic agents [34]. The major aroma constituents of *Syzygium aromaticum* buds were eugenol and eugenyl acetate [35]. Eugenol was reported to have antifungal activity [36] and inhibited malonaldehyde formation from cod liver oil and the formation of hexanal [35]. It has been found that clove buds exhibit antioxidant properties [37]. Clove essential oils have been analyzed by gas chromatography mass spectrometry (GC-MS) and 18 components found in essential oils. These components have been tested for antioxidant properties in an egg yolk-based thiobarbituric acid reactive substances (TBARS) assay and also undiluted in a β-carotene agar diffusion assay. The essential oils and the components tested in the TBARS assay have demonstrated some degree of antioxidant activity [38]. In addition, the effect of clove oil on the oxidative stability has also been reported [39]. Eugenol (4-allyl-2-methoxyphenol) is the active antioxidant substance which makes up 90–95% of the clove oil [40], and as a food additive is classified by the United States Food and Drug Administration (FDA) to be a substance that is generally regarded as safe (GRAS) [41]. The essential oil of clove has been tested for inhibitory activity against important microorganisms in food industries [42]. Clove oil has been listed as a GRAS substance as approved by FDA provided that level is less than 1500 part per million (ppm) in all food categories [43].

**Cornelian cherry**

Cornelian cherry or European cornel (*Cornus mas*), is one of the few members of dogwood native to Iran, southern Europe and southwest Asia. It is a medium shrub or small tree growing to 5–12 m tall, with dark brown branches and greenish twigs. The fruit is an oval red drupe 2 cm long and 1.5 cm in diameter, containing a single seed. The berries when ripe on the plant bear a resemblance to coffee berries, and ripen in mid to late summer. The fruit is edible, especially in Iran, but the unripe fruit is astringent. The fruit only fully ripens after it falls from the tree. When ripe, the fruit is dark ruby red. In Iranian tradition, it is used for making jam or used as a cold drink or salted snack in summer and its local name is *Zoghal Akhte*. It has been reported that the content of vitamin C, an important water soluble antioxidant, in this special type of fruit is about twice of oranges [44]). As well as having high nutrition value, fruits of cornelian cherry are rich sources of antioxidants and anthocyanins [45]. It has been found that various genotypes of cornelian cherry fruits found in north of Iran are rich sources of various antioxidants including phenolic compounds, anthocyanins, total
flavonoids and ascorbic acids [46]. It can be suggested that, as their anthocyanins content is low, similar to strawberries [47], most of observed antioxidant activity must be related to their total phenol content.

Many investigations have clearly indicated that the fruit could be a significant source of phenolic compounds and anthocyanins with high antioxidant activity, which may vary greatly among its genotypes. Therefore, consumption of cornelian cherry as a source of natural antioxidants, natural colorants and an ingredient of functional foods could introduce many health benefits.

**Edible chestnuts**

The chestnut (*Castanea sativa*) is originally from Europe, but it grows in some parts of forest covered north of Iran. Among the 12 world chestnut species, this one is the most widely consumed. For therapeutic purposes, the harvested parts of the edible chestnut are the bark, flowers, leaves and seeds. The fruits are a source of carbohydrates, phosphorus, lecithin and vitamin C. They also contain protides, fat, calcium, iron, magnesium, manganese, zinc, potassium and their caloric value is 200 calories per 100 g. It has already been demonstrated that chestnut fruits [48], leaves, barks [49], skins and flowers contain phenolic compounds [50]. It has been found that using various extraction conditions, the antioxidant activity and the total phenolic content of the extracts are greater in chestnut shell than in eucalyptus bark [49]. Chestnuts act as a tonic for the muscles, nerves and veins and reduce capillary permeability. In cosmetics products, the chestnut honey mask is used for all skin types, because of its anti-inflammatory properties, reducing capillary fragility, protecting from UV radiation. The antioxidant activity of chestnut fruits is highly dependent on ecotypes. Climatic conditions as well as type of the plant and stress status could be a determining factor for production of phenolic compounds and consequently for the antioxidant properties of chestnut nuts. It has been reported that, the coldest ecotypes could be an excellent natural source of polyphenols, having therefore, a good potential to be used as a source of natural antioxidants on the diet [51].

**Garlic**

Garlic (*Allium sativum* L.) is a plant native to Africa and central Asia. The active compounds of garlic are volatile oil, the mixture between sulfide and allyl oxide in an almost pure state, two very important mineral antibiotic components (sulfur, iodine, zinc, and manganese) and vitamins B and C. The main therapeutic qualities of garlic describe it as being antiseptic,
antibacterial, stimulating digestion, reducing high blood pressure, glandular regulator, diuretic and even cancer deterrent. Despite its wide range of medicinal benefits, garlic is not used, especially as a raw vegetable due to the strong smell that remains in the mouth. However, in Gilan province its smell is milder, more tolerable and accepted. It is traditionally used for treating various afflictions including treating pharyngitis and intestinal infections. It has been investigated that garlic essential oil is highly effective in scavenging free radical and has the potential to be powerful antioxidant.

Garlic possesses many healthful properties that are related to its bioactive compounds [52], [53], [54] and [55]. It was reported that consumption of garlic is very helpful in regulating plasma lipid levels [56] as well as plasma anticoagulant activity [57] and [58] and in prevention of the atherosclerosis process [59] and even cancer [60].

The antioxidant properties of garlic and different garlic preparations are well documented. The main antioxidant compounds found in various extracts of garlic are found to be phenolics and flavonoids and their composition depends on the extraction solvent and technique used [61].

In most of Gilan traditional dishes, garlic is usually used as fried in olive oil. The interesting point is that a recent finding about ready to eat garlic products, has reported that amongst all the analysed garlic products, fried form exhibited the highest antioxidant activity. It was also shown that the free radical-scavenging activity decreased during the shelf life of all tested products that correlated with the decrease in the total polyphenol content. They, therefore, suggested that some compounds other than phenol may have contributed to antioxidant activity [62].

**Horseradish**

Horseradish (*Armoracia rusticana*) is a strong seasoning successfully used in phytotherapy. Because of its spicy flavor the horseradish root is used in conserving the canned food for the winter but is also used throughout the year in preparing various meal recipes. It originated in south-eastern Europe and western Asia and it is resistant to the low temperatures as well as to droughts.

As a medicine horseradish root has many curative properties: strong antibiotic, expectorant, bronchodilatator, antioxidant, coronary vasodilatator, it increases the blood pressure, it heats up the body, stimulates the body's immune system, anti-inflammatory, antiparasitic, antianemic, antiscorbutic, diuretic. Horseradish is the most important plant source for peroxidase, the heme containing antioxidant enzymes found in prokaryotic and eukaryotic organisms. The enzyme is called horseradish peroxidase (HRP) and possesses...
many industrial applications [63]. It is isolated and purified from horseradish (*Armoracia rusticana*) and is an example of the plant proteins and enzymes containing the heme group. It is often used for the investigation of the interaction between trace elements and peroxidase. Seven isoenzymes of HRP have been identified, among which the c isoenzyme of HRP (HRPc) is the most abundant and has been successfully isolated, purified and characterized [64]. It has a cardiotonic effect and is recommended to the people that suffer from high blood pressure.

**Lavender**

Lavender is a herbaceous plant from the Labiatae family and is used in medicine, perfume industry and alimentary industry. The plant can be adapted well to droughty conditions and wet climates. In Gilan province it grows very nicely and is used as decoration as well as medicinal purposes. Dried lavender flowers are used to prepare a series of natural remedies with wound healing, antiseptic, calming and relaxing effects. Containing tannin, mineral substances, essential oils, lavender flowers have an antiseptic, calming and carminative activity, and nerve stimulating effects. They are used in cases of digestive disorder, as a flavoring and remedy agent, in hypertension, cardiac affections, headaches, insomnia, melancholia, dizziness or bronchial asthma. It is known traditionally that the plant's oil is a good disinfectant of wounds and burns. In case of solar burns a few drops of lavender oil are added into mineral water, which is then used to moisten the affected area. In home prescriptions, lavender tea is prepared with two teaspoons of flowers to a cup of boiled water to drink hot and sweetened with honey. In traditional cosmetic use, lavender water, prepared from fresh flowers macerate in 50% ethanol, is used for refreshing the skin.

Lavender (*Lavandula angustifolia*) is well known to possess anxiolytic, sedative and calming properties [65]. In human, lavender provides a more gentle treatment compared to conventional anxiolytic drugs. Lavender has been extensively studied phytochemically, with limited work on pharmacological aspects and is used by traditional healers for various diseases of the central nervous system, like epilepsy and migraine. It is also used in folk medicine, as an antioxidant [66] with analgesic [32] and antimicrobial [67] effects. Traditionally, the plant leaves are used in epilepsy and as a sedative remedy [68].

The antioxidant activity of essential oils and dried deodorised aqueous extracts of lavender have been assessed by the β-carotene bleaching test [69]. Other chemical techniques have also been used to assess the antioxidant activity of the plant [70,71]. It has been shown that ethanolic extracts of
lavender leaves play strong antioxidant activity against oxidative deterioration of lard [72]. The aerial parts of the plant contain oleanolic acid, ursolic acid, vergatic acid, β-sitosterol, α-amyrin, flavonoids, luteolin, acacetin, vitexin [73] and two longipinane derivatives; longipin-2-ene, 7β, 9α-diol-1-one and longipin-2-ene, 7β, 9α-diol-1-one-monoacetate [74].

Lemon

Lemon (*Citrus Limon*) is a member of citrus family which originates in India. Lemon is well known not only as an aliment but also for its therapeutic properties. In aromatherapy, essential lemon oil is used in treating hepatic affections. Because of its chemical composition, especially because of its rich containment of vitamin C, the fruit is a potent natural antioxidant. On the other hand, vitamin C has an important role in the synthesis of collagen in the tissues, cartilages and bones, also being anti-inflammatory. Lemon is also used successfully for preparing products with cosmetic purpose. Citric acid, which is also found in lemon, is able to stimulate the absorption of calcium through the intestines (mineralization action), neutralize the effect of uric acid and reduces the gastric acidity. It has been found that lemon is a strong antioxidant, antibacterial, diuretic, anti-rheumatic, anti-gout, and stimulates gastro-hepatic and pancreatic secretions. It has been shown that lemons are essential sources of many important natural chemical components such as citric acid, ascorbic acid, minerals, flavonoids and essential oils. GC/MS analysis has revealed the volatile fraction of alcoholic extracts obtained from *Sfusato Amalfitano* and *Ovale di Sorrento* possesses potent antioxidant activity and the quantity depended on season of plantation [75]. It is known that lemon (*Citrus limon*) is the third most important citrus crop [76]. Being a rich source of nutrients the fruit could provide many health benefits. The most important medicinal compounds identified in lemon include vitamin C (ascorbic acid + dehidroascorbic acid), minerals, citric acid, and flavonoids [76]. It is well known that vitamin C is the most important water-soluble antioxidant and a potent ROS scavenger. The most abundant flavonoids in lemon include hesperidin and eriocitrin (flavanones), vicenin-2 (flavone), diosmin (flavone), quercetin and myricetin (flavanols) as well as other hydroxycinnamic acids and diosmetin glycosides (flavones) [77].

Lettuce

Lettuce with scientific name of *Lactuca sativa* is commonly called as green salad and is grown almost all year round. It can be grown in greenhouses and is one of the first vegetables that appear in spring. Lettuce
can replace a heavy diet and stimulates appetite, reinvigorates and cleanse the body of the accumulated toxins. It also contributes to fighting against the deficit of hemoglobin and mineral salts from the body. In addition to carbohydrates, lettuce contains minerals including calcium, phosphorus, iodine, iron, copper, arsenic as well as almost all vitamins. Having high content of vitamin C, lettuce increases the resistance to infection and virus and fights anemia. Lettuce has a special role in regulating the digestion and intestinal transit, having great effects for those who suffer from constipation, as a laxative.

It has been investigated and found that red lettuce show higher antioxidant activity compared to the common greenish type [78]. This is due to the presence of pigments in red lettuce that attribute to the accumulation of anthocyanins. These later are water-soluble antioxidants derived from flavonoids via the phenylpropanoid pathway. The phytochemicals including antioxidant compounds in lettuce are mostly secondary metabolites that are synthesized during the normal growth of plants or in response to a number of environmental conditions [79,80]. The level of enzymatic and non-enzymatic antioxidant in various types of lettuce depends on temperature and low temperatures lead to an increase of anthocyanin and polyphenol production as well as an increase in antioxidant and polyphenol oxidase (PPO) activities in lettuce plants [78].

Mint

The Labiatae family includes about 220 genera and 3300 species which are widely used for various purposes [81]. Plants belonging to the Labiatae family are rich in polyphenolic compounds and a large number of them are well known for their antioxidant properties [82]. Their antioxidant properties are mostly related to the presence of carotenoids typical for this type of herbs [83]. The Mentha genus is a member of this family and represents by about 6 species in the flora of Iran [84]. Mentha species are generally known under the name “‘na’na” and “pooneh” in Iran and commonly used as herbal tea, flavoring agent, and medicinal plant [81]. About 15 components have been identified by the GC mass analysis [83]. However, its essential oil is a complex mixture of much more chemicals and pulegone and menthone were the most abundant compounds found. It has been shown that essential oil from *M. pulegium* of Gilan is potent antioxidant and also highly active against *S. mutans*, the Gram positive bacterial strain. It is able to inhibit the growth of some Gram negative bacteria including *K. oxytoica, P. aeruginosa* and *E. coli* when tested by disk diffusion. Although the essential oil from *M. pulegium* is a suitable candidate for food industry as a natural
preservative. However, its antimicrobial activity may be improved if other food preservation methodologies are also used [85,86].

**Olive**

The olive (*Olea europaea*) is a species of a small tree in the family Oleaceae, native to the coastal areas of the eastern Mediterranean Basin as well as northern Iraq, and northern Iran at the south end of the Caspian Sea called Rudbar. Its fruit is also named the olive, and could be a major source of olive oil. The olive tree and olives are mentioned over 30 times in the Bible [87], and seven times in the Quran and the olive is praised as a precious fruit [88].

Olives and olive oil contains different antioxidant systems, most importantly polyphenols such as oleuropein, hydroxy-tyrosol and tyrosol [89], rutin [90], quercetin [91] as well as caffeic, vanillic and *o-* and *p-*coumaric acids [92]. It has been reported that oleuropein and hydroxy-tyrosol enhanced the oxidative stability of oil-in-water emulsions, while quercetin inhibited lipid oxidation in beef [93].

The presence of high amounts of polyphenols as potent antioxidant has caused a remarkable resistance to oxidation in olive oil [94]. It is also suggested that the oxidative stability of canned fish improve when extra virgin olive oil used as a filling medium instead of refined oils [95]. On the other hand, it was found that frying beef in virgin olive oil could reduce known carcinogenic compounds [96]. While olive is very high source of polyphenolic antioxidants, but it has been reported that almost all polyphenols (about 98%) is lost in the waste waters and solid phase during oil extraction [97].

**Parsley**

Parsley (*Petroselinum hortense*) is a common herb used in most of traditional Iranian foods both dried and fresh. It is believed that the plant is good for cancer prevention, as antirheumatic, stimulant of digestion, and cleaning kidney from toxins and stones. Fresh parsley leaves are quite rich in ascorbic acid, a vitamin and a powerful antioxidant. The fresh leaves of parsley contain more vitamin C than lemon, orange or any other fruit so that only 25-30 mg of its fresh leaves provide our daily need of vitamin C. It also contain significant amounts of other micronutrients including provitamine A, B, E and K vitamins, beta-carotene, magnesium, phosphorus, iron, manganese, sodium, potassium, sulfur and calcium. Water extracts of parsley
possess strong antioxidant and antibacterial activity. With this wide range of active antioxidants, parsley can strongly neutralize the negative effects of smoking and dependence upon alcohol. The use of fresh leaves, as a food ingredient, can straighten the body and immune system. Fresh and dried parsley inhibit the growth of *Listeria monocytogenes*, *L. innocua*, *Escherichia coli* O157:H7, *E. coli* Bs-1 and *E. carotovora* [81]. The essential oil prepared from fresh parsley leaves has growth inhibition properties towards numerous Gram-positive and Gram-negative bacteria [98]. The antioxidant activity of fresh leaves extracted with hot water has been studies [99]. It has been shown that various extraction techniques could reserve the antioxidant action of the plant. It is suggested that phenolic compounds are major components responsible for antioxidant activity in most plants including parasely [100].

**Peanut**

The peanut, or groundnut (*Arachis hypogaea*), is a species in the legume or "bean" family (Fabaceae). In Iran, peanut is commonly called ground nut and is grown in the province of Gilan, an area called Astaneh and is exported from this place to other parts of the country. Peanuts are particularly susceptible to contamination during growth and storage. Poor storage of peanuts can lead to an infection by the mold fungus *Aspergillus flavus*, releasing the toxic and highly carcinogenic substance aflatoxin.

In addition to containing unsaturated fatty acids and being good sources of fibre and protein, peanuts are rich sources of antioxidants capable of directly scavenging free radicals. These include various polyphenolics (coumaric acid, ferulic acid, resveratrol, etc.), tocopherols, flavonoids (procyanidins, catechin, etc.) and folate [101,102]. Peanut skin is also a rich source of medicinal secondary metabolites. It has been shown that the amount of bioactive compounds in peanut skins depends on the type of processing method used. On the other hand, it has been found that total antioxidant and free radical scavenging activities of water and ethanol extracts of peanut skins are even higher than green tea and vitamin C [103]. However, the total phenolic content and antioxidant capacity of peanut skins varies greatly between different peanut species [104].

**Persian lime**

Persian lime (*Citrus latifolia*), another member of genus (*Citrus*), is flowering plants in the rue family, Rutaceae. These plants are large shrubs or small trees, reaching 5–15 m tall, with spiny shoots and alternately arranged evergreen leaves with an entire margin.
Citrus fruits are notable for their fragrance, partly due to the presence of important terpenes such as flavonoids and limonoids. The juice contains a high quantity of citric acid, vitamin C and flavonoids. The flavonoids include various flavanones and flavones.

In Persian traditional medicine lemon and lime juices are used to relieve the pain of bee stings. The peels are used as a facial cleanser and also in making a home made jam. Many citrus fruits are grown in North of Iran and are commonly used for their high content of vitamin C, which prevents scurvy. Due to their high citric acid content, citrus fruit juices, in general, are useful for lowering the risk factors for calcium oxalate type of kidney stones. The composition, antioxidant and antimicrobial activity of essential oil of lime has been studied widely [105]. It is also demonstrated that the essential oil from lime residues contain a variety of natural compounds essential for human healthy [106]. A research on water extracts of mixed lemon and lime wastes has demonstrated antioxidant activity comparable to the juices or whole fruits [107]. The fresh juice of many citrus fruits are rich in water soluble antioxidants, However, it is interesting to add that sonication treatments of lime fruit juice can significantly improve its bioactive compounds, especially antioxidants, while reducing the microbial counts [108].

**Persian walnut**

Walnut is an edible seed of any tree of the genus *Juglans*, especially the Persian walnut, (*Juglans regia*). Walnut seeds are high density source of nutrients, particularly proteins and essential fatty acids. The seed kernels are enclosed in a brown seed coat which contains antioxidants. The antioxidants protect the oil-rich seed from atmospheric oxygen so preventing rancidity. The English walnut is originated in Persia and is exported from Iran to many European countries. In north of Iran, walnuts are commonly consumed in many food recopies as well as using as a nut.

Unlike most nuts that are high in monounsaturated fatty acids, walnuts are composed largely of polyunsaturated fatty acids, particularly alpha-linolenic acid and linoleic acid as well as a range of antioxidants [109]. It has been shown that consumption of walnuts not only increases the antioxidant capacity but it also could reduce the risk of cancer [110]. It has been suggested that walnut consumption could improve the use of body fat in overweight adults [111]. Walnut fruit contains high phenolic content, antioxidant activity, and potent *in vitro* antiproliferative activity [110]. It has the highest antioxidant power compared to other nuts, such as almonds, peanuts and hazelnuts.
Pomegranate

The pomegranate (*Punica granatum*) is a fruit-bearing deciduous shrub or small tree growing between five and eight meters tall. The plant is native to the region of Persia and the western Himalayan range, and has been cultivated in Iran, Iraq, Azerbaijan, Afghanistan, Pakistan, Northern India, Russia, and the Mediterranean region for several millennia.

Iran produces significant amount of high quality pomegranate. Its juice and in particular the paste has an essential role in some of the Iranian cuisines such as Fesenjoon and a home made processed olive recipe. The dye extracted from skin of pomegranate is traditionally used for staining wool and silk in the Iranian famous hand crafted carpets. In addition you can find a pomegranate juice bar in every corner of the shopping centers and tourists entertaining places. Traditionally, in Iran pomegranate is used as a contraceptive and abortifacient taking the whole fruit including the seeds, or rind with its juice.

In ancient Persian culture pomegranate was the symbol of fertility and it is still recommended to pregnant mother to eat most of the time. According to the Qur'an, pomegranates grow in the gardens of paradise [88]. The Qur'an also mentions pomegranates three times as examples of good things God creates [88]. Pomegranate aril juice provides about 16% of an adult's daily vitamin C requirement per 100 ml serving, and is a good source of vitamin B₅ (pantothenic acid), potassium and polyphenols, such as ellagitannins and flavonoids [112].

The edible seeds of pomegranates are rich sources of plant type fibers, natural antioxidants and essential fatty acids. The most abundant antioxidants found in pomegranate juice are polyphenols. These include hydrolyzable tannins called ellagitannins formed when ellagic acid binds with a carbohydrate. It has been suggested that punicalagins from tannins possess a potent power of ROS scavenging [113]. Various types of punicalagins are present in *P. granatum* including granatin A and B, punicacortein A, B, C and D, 5-O-galloylpunicacortein D, punicafolin, punigluconin, punicalagin, 1-alpha-O-galloylpunicalagin, punicalin and 2-O-galloyl-punicalin and their relative proportion depend on extraction technique, the plant part and the species under investigation [113].

Clinical trials have revealed that juice of the pomegranate is effective in reducing heart disease risk factors including LDL oxidation [114], macrophage oxidative status [115], and foam cell formation and act as anti-inflammatory medication [116]. The fresh juice of pomegranate has been shown to lower lipid levels in diabetic patients suffering from increased
triglycerides [117] as well as reducing cholesterol to ease atherosclerotic by reducing macrophase lipid peroxidation in experimental mice [118].

**Pumpkin**

Pumpkins belong to the family of *Cucurbitaceae*. They are classified to *Cucurbita pepo*, *Cucurbita moschata*, *Cucurbita maxima* and *Cucurbita mixta*, according to the texture and shape of their stems. The presence of carotenoid type antioxidants has given the yellow-orange color pumpkin. It is a reach source of various antioxidant systems, most important of which is β-carotene. The pumpkin pulp contains vitamins, especially provitamin A, vitamin E and C, mineral salts, carbohydrates and the seeds contain oil, lecithin and various enzymes including antioxidant enzymes such as peroxidase and superoxide dismutase.

In north of Iran (Astaneh), where it is cultivated, pumpkin is used in a wide variety of traditional preparations such as steamed, in cakes, in soups; and fried. Pumpkin seeds are also used either raw or roasted in cooking and baking as an ingredient of bread, cereals, salads and cakes. It has been reported that pumpkin seeds provide many health benefits. They are rich sources of natural beneficial nutrients including proteins, phytosterols [119,120], polyunsaturated fatty acids and fibers [121], antioxidant vitamins, [122] and trace elements, such as zinc [123]. The presence of molecular species being able to scavenge radicals and inhibit lipoxygenase in pumpkin seeds is also contributed to their health benefits. The seeds especially contain omega 6 fatty acids with a number of biological applications such as significant antioxidant, anti-inflammatory and hypolipidemic effects [124]. The type of solvent used to prepare pumpkin seed extracts affect its antioxidant properties. Polar solvents are able to extract higher amounts of phenolics, while reduction in solvent polarity decreases the phenol contents in the extracts leading to lower antioxidant activity [125]. It has been shown that pumpkin seed extracts of different polarity and phenolic content are able both to quench free radicals and to inhibit lipid peroxidation catalyzed by lipoxygenase [125]. Therefore, the relative concentration of each species of phenolic molecules determines the antioxidant potential of the extracts. The presence of molecules being able to scavenge radicals and inhibit lipoxygenase in pumpkin seeds may in part explain their health benefits.

**Soybean**

Soy is a leguminous plant, known and used as human food source for 5000 years, first in China, then in the Far East. It is an annual plant,
cultivated for its seeds and buds. Most of traditional physicians in Iran believe that soy can heal any health related problem. The plant is cultivated in north of Iran, mostly around a city by Caspean Sea (Astaneh). In Iran, soybeans are consumed as a snack as well as a replacement for meat in many types of food preparations. It is also the basis for a number of totally or partially vegetarian diets. Traditionally, soy is known for its many health benefits including reducing cholesterol, preventing hypertension, reducing the negative effects of menopause and minimizing the risk of gout. Soy contains a group of important antioxidants known as isoflavonoids as well as many important nutrients including protein, iron, vitamin C and fibers. The plant is an excellent source of albumin, potassium, magnesium, phosphorus, calcium and vitamin E.

It is known that the most important antioxidant components introducing benefits of the soy products are isoflavones, genistein and daidzein [126]. Consumption of soybean isoflavones could protect against DNA oxidation in human lymphocytes [127]. Both genistein and daidzein, in soybean, are mainly present in the form of their glycosides. Isoflavone glycosides are hydrolyzed to their corresponding aglycones before absorbed in gastrointestinal tract [128]. On the other hand, it has been demonstrated that flavonoid glycosides, including genistin, phloretin and quercetin, can be partially absorbed without hydrolysis of glucose moieties [126]. In human blood, most of the genistein and daidzein is present in the form of glucuronide and sulfate conjugates [129]. The presence of tocopherols as potent antioxidants in soybean could cause their interaction to membrane phospholipids leading to their synergic antioxidant activity. The synergism of phospholipids and tocopherols has been studied by nuclear magnetic resonance (NMR) [130]. The antioxidant and antimicrobial properties of phospholipid have also shown alternations due to complexing with quercetin [131,132]. The mechanism of interaction between lecithin, quercetin and tocopherols has been examined when added to sunflower oil (SFO) and triolein models during accelerated oxidation test. The results have revealed the differences in oxidative strength of complex lipids with phenolics [133].

### Spinach

Spinach (*Spinacia oleracea*) is an annual plant originating in the Middle East. Some assign its origin to Iran. Nowadays, spinach is a very well known plant, especially for its rich iron content. As spinach also contains oxalic acid, a substance that inhibits the absorption of calcium into the body, its use must be balanced to prevent over doses. Due to its rich iron content, spinach has become a much appreciated herb due to recent studies which prove its anti-
cancerigenic properties. Spinach contains an impressive range of active substances including mineral salts (sodium, potassium, calcium, phosphorus, magnesium, sulfur, iron, zinc, manganese, iodine, copper), vitamins (C, B1, B2, B6, PP, E, K, folic acid, vitamin A), chlorophyll, amino acids (arginine and lysine), lipids, proteins, carbohydrates and fibers. In Iranian folk medicine, spinach is used to reduce arterial hypertension, renal affections, cystitis, diabetes, gout, renal insufficiency, obesity, eczemas, acne and burns. Also a fresh glass of spinach juice is drunk in the morning to prevent constipation.

Its strong antioxidant power is exhibited when spinach is used as an external remedy for burns. According to Iranian traditional pharmacy, spinach leaves are soaked in boiling olive or soybean oil and they are fastened with a bandage on the affected areas. Various powerful water soluble antioxidants with potential biological activity have been found in spinach leaves [134]. Water spinach (Ipomoea aquatica), another genotype of spinach found in north of Iran, has shown to contain significant amounts of various antioxidants including violaxanthin, lutein and β-carotene [135]. A novel glucurinated flavonoid antioxidant has also been isolated and purified from spinach with strong radical scavenging activity [136]. Extracts of commercial brown seaweed (Ascophyllum nodosum) has shown to increase phenolic antioxidant content of spinach (Spinacia oleracea L.) making it a powerful remedy for oxidative and thermal stress [137].

Tea

Tea (Camellia sinensis) is a shrub native to India, and has been cultivated in North of Iran (Lahijan) more that 100 years ago. There are three types of tea depending on the level of fermentation, i.e., green (unfermented), oolong (partially fermented) and black (fermented) tea. Many health benefits of various types of tea have been known up to present time. In general, green tea has been found to be superior to black tea in terms of antioxidant activity owing to the higher content of (−)-epigallocatechin gallate. The processes used in the manufacture of black tea are known to decrease levels of the monomeric catechins to a much greater extent than the less severe conditions applied to other teas. As a beverage, tea is prepared by adding cured leaves of the plant to hot water. Among its many health benefits the high antioxidant activity due to the presence of flavanols, flavonoids, and polyphenols [14, 138] has been mostly studied. On the other hand, it has been found that drinking green tea could reduce the risk of stroke, cognitive impairment, and osteoporosis in the elderly [139]. Tea is the most widely consumed and loved drink in the world. It has a cooling, slightly bitter, astringent flavour which
many people enjoy. The synergism of tea with other medicinal and aromatic plants increases its beneficial antioxidant activity. This type of mixed tea is known as *herbal tea* which is made from infusions of fruit or herbs made without the tea plant, such as *rosehip tea* or *chamomile tea*.

The most known antioxidant compounds present in tea are catechins (Figure 6). A number of other medicinal compounds including L-theanine, caffeine, theobromine and theophylline have been reported to be significantly present in tea [140].

*Figure 6. Structure of some polyphenols in tea.*
It has been reported that tea leaves contain more than 700 chemicals, among which the compounds closely related to human health are flavanoids, amino acids, vitamins (C, E and K), caffeine and polysaccharides [141]. Tea plays an important role in improving beneficial intestinal microflora, as well as providing immunity against intestinal disorders and in protecting cell membranes from oxidative damage.

Tea also prevents dental caries due to the presence of fluorine. The role of tea is well established in normalizing blood pressure, lipid depressing activity, prevention of coronary heart diseases and diabetes by reducing the blood-glucose activity. Tea also possesses antibacterial activities against various gram-positive and gram negative human pathogenic bacteria. The presence of antioxidants, mainly catechins, in tea have anti-carcinogenic, anti-mutagenic and anti-tumoric properties [142].

Numerous recent epidemiological studies have been conducted to investigate the effects of green tea consumption on the incidence of human cancers. These studies suggest that green tea infusions could show significant protective effects through antioxidant mechanism. Therefore, it can protect human body against oral, pharyngeal, esophageal, prostate, digestive, urinary tract, pancreatic, bladder, skin, lung, colon, breast, and liver cancers, and lower risk for cancer metastasis and recurrence [138]. Due to its high antioxidant capability, green tea could significantly reduce the risk of ovarian and endometrial cancers [143], and advanced skin cancer [144, 145]. In Persian culture, tea is widely used and it is generally the first thing to have in the morning and offered to a guest. Among various types of tea from Gilan province, we found that white tea contained the highest antioxidant activity. On the other hand, wates from tea factory in Lahijan showed unexpected antioxidant activity comparable to green tea [146]. Being a famous and important beverage common in Iran, especially, north of the country and the suitable nature in Gilan, this province is a central research center for tea and various manufactures related to this strategic plant of the country.

Conclusions

Twenty three most commonly known medicinal fruits and vegetables of Gilan region have been reviewed for their antioxidant properties. It was noticed that flavanoids, polyphenols and tannins are the most common and potent antioxidants followed by ascorbic acid and alkaloids in most of these plants. The mechanism of action of some of the identified natural antioxidants is known. However, a wide range of other active antioxidants with possibly different mechanism in other plants are remained to be identified. This review chapter has opened the gate to getting familiar with a
wide range of medicinal plants in north of Iran and their potential as potent antioxidants of plant origin. Central northern Iran is a longitude area along south of Caspean Sea with a mediterranian like weather, but slightly cooler. The type of vegetation and wild medicinal plants are different from other parts of the country.

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