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Review on plants having antioxidants properties

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Abstract
Antioxidants or inhibitors of oxidation are compounds which retard or prevent the oxidation and in general prolong the life of the oxidizable matter. Majority of the diseases/disorders are mainly linked to oxidative stress due to free radicals. The free radicals (oxidants) are species with very short half-life, high reactivity and damaging activity towards macromolecules like proteins, DNA and lipids. In general, the reactive oxygen species circulating in the body tend to react with the electron of other molecules in the body and these also effect various enzyme systems and cause damage which may further contribute to conditions such as cancer, ischemia, aging, adult respiratory distress syndromes, rheumatoid arthritis etc. A plant based diet protects against chronic oxidative stress-related diseases. Dietary plants contain variable chemical families and amounts of antioxidants. It has been hypothesized that plant antioxidants may contribute to the beneficial health effects of dietary plants. This review presents some information about the antioxidant/antiradicals and their role in our body and also their presence in spices and herbs.

Keywords: antioxidants, free radicals, herbal plants

Introduction
Natural compounds from plants and other life forms (bacteria, fungi, marine organisms) represent a major source of molecules with medicinal properties. Among them, antioxidant substances are of particular interest. The understanding of the central role that oxidative stress holds in the progression of disorders as varied as: cardiovascular diseases, degenerative conditions, rheumatic disorders, metabolic syndrome, and in aging, makes antioxidant capacity to a key-feature of modern, multipotent remedies. A lot of medicinal plants, traditionally used for thousands of years, are present in a group of herbal preparations of the Indian traditional health care system (Ayurveda) named Rasayana proposed for their interesting antioxidant activities.

Antioxidants are substances that may protect your cells against the effects of free radicals. Free radicals are molecules produced when your body breaks down food, or by environmental exposures like tobacco smoke and radiation. Free radicals can damage cells, and may play a role in heart disease, cancer and other diseases. Studies suggest that a diet high in antioxidants from fruits and vegetables is associated with a lower risk of cancer, cardiovascular disease, Parkinson's disease and Alzheimer's disease. A plant-based diet protects against chronic oxidative stress-related diseases. Dietary plants contain variable chemical families and amounts of antioxidants. It has been hypothesized that plant antioxidants may contribute to the beneficial health effects of dietary plants. Our objective was to develop a comprehensive food database consisting of the total antioxidant content of typical foods as well as other dietary items such as traditional medicine plants, herbs and spices and dietary supplements.

Since ancient times, the medicinal properties of the plant materials improve the quality and nutritional value of plants has been investigated in the recent scientific form. While, flavonoids are a group of polyphenolic developments throughout the world, due to their potent compounds with known properties, which include free antioxidant activities. The antioxidants have been reported to have radical scavenging, inhibition of hydrolytic and oxidative to prevent oxidative damage caused by free radicaL.

The free radicals may be either Oxygen derived (ROS) or Nitrogen derived (RNS). The most common reactive oxygen species include superoxide anion (O2), hydrogen peroxide (H2O2), peroxyl radicals (ROO) and reactive hydroxyl radicals (OH).

The nitrogen derived free radicals are nitric oxide (NO), peroxy nitrite anion (ONOO), Nitrogen dioxide (NO2) and Dinitrogen trioxide (N2O3) [1.2,11]

The exogenous sources of ROS include electromagnetic radiation, cosmic radiation, UV-light, ozone, cigarette smoke and low wavelength electromagnetic radiations and endogenous sources are mitochondrial electron transport chain, β-oxidation of fat, superoxide dismutase, ferritin, transferrin, reruloplasmin, tocopherol, carotene and ascorbic acid. Chemical compounds and reaction capable of generating potential toxic oxygen species/free radicals are referred to as 'pro-oxidants'. They attack macromolecules including protein, DNA and lipid causing to cellular/tissue damage on the other hand, compounds and reactions disposing of these species, scavenging them suppressing their formation or opposing their actions are called antioxidants. In a normal cell there is an appropriate pro-oxidant: antioxidant balance. However, this balance can be shifted towards the pro-oxidant when production of oxygen species is increased or when levels of antioxidants are diminished. This state is called 'oxidative stress' and can result in serious cell damage if the stress is massive or prolonged [4].

Free radicals are atoms or molecules with singlet, i.e. unpaired electron which makes them highly reactive. Oxidative free radicals are generated by metabolic reactions create a chain reaction leading to membrane and other lipid peroxidation, DNA damage, etc. This has been implicated in atherosclerosis (oxidated LDL is more atherogenic), cancers, neurodegenerative and inflammatory bowel diseases.

Small amounts of reactive oxygen species are continually formed in the body in the cell membrane and close to the cells organelles. They act where they are generated. Hence, they can damage most cell structures including membrane lipids, proteins, enzymes and nucleic acids.

The body has mechanisms to produce the small amounts of oxidants normally formed during metabolic reaction. Reactive species such oxidants are formed in controlled amounts by neutrophil leucocytes on exposure to microbes are beneficial to the body in that they participate in destroying the microbes. Excess of oxidants, however, can be harmful to the body. Liver is also under constant threat of oxidants and some of the free radical especially H2O2. Lipid peroxidation has been demostred as one of the important feature after exposure to hepatotoxic substances and also is a measure of extent of hepatic damage. Several herbs and herbal formulations are available for the scavenging activity. In addition to this there is a global trend to revive the traditional systems of medicines and renewed interest in the natural remedies for treating human ailments. Antioxidants have important preventive roles, not only on undesirable changes in the flavor and nutritional quality of food, but also on tissue damage in various human diseases. Almost all organisms are well protected against free radical damage by either enzymes or compounds, such as ascorbic acid, α- tocopherol and gluthione.[7]

When the mechanism of antioxidant protection unbalanced by the deterioration of different factors, physiological functions can occur which result in diseases or accelerated aging. Consequently, it is important to find compounds that prevent oxidation. Antioxidants have important preventive roles not only on undesirable changes in the flavor and nutritional quality of food, but also on tissue damage in various human diseases. They are effective in prevention of degenerative illnesses, such as different types of cancers, cardiovascular and neurological diseases, cataracts and oxidative stress dysfunctions. Polyphenols are the most significant compounds for the antioxidant properties of plant raw materials. Then antioxidant activity of polyphenols is mainly due to their redox properties, which allow them to act as reducing agents, hydrogen donors, singlet oxygen quenchers, metal chelators and reductants of ferryl hemoglobin. Medicinal plant parts are commonly rich in phenolic compounds, such as flavonoids, phenolic acids, stilbenes, tannins, coumarins, lignans and lignins. These compounds have multiple biological effects including antioxidant activity.

Table 1: List of plants exhibit antioxidant characteristics and their chemical constituents

S. No	Plant Name	Plant Part	Main Chemical Constituents
1.	*Withania somnifera*	Berries, leaves, roots	Ascorbic acid,α-tocopherol and reduced glutathione, superoxide dismutase, ascorbate peroxidase, catalase, peroxidase & polyphenol oxidase
2.	*Ocimum sanctum*	Leaves, seeds	Oleanolic acid, linalon, carvacrol
3.	*Piper nigrum*	Fruits	Piperine, alkamides
4.	*Arentium lappalo*	Root	Ascorbic acid,β-carotene, β-sitosterol, eugenol, Palmitic acid, tannin
5.	*Scutelleria barbata*	Leaves	Ascorbic acid, β carotene, auric acid, myristic acid, palmitic acid, piperine
6.	*Daucus carrota*	Leaves, seed, root	Insulin, tannic acid Gallic acid
7.	*Coleus ferscoli*	Roots	Alanine, α tocopherol, ascorbic acid, camphene,eugenol,γ- terpinene, histidine Antitoxin, Ferscolin
8.	*Salvia sclarea*	Entire plant, seed	ɣ-terpinene, linalyl acetate, myrcene,
9.	*Eugenia caryophylla*	Inflorescence	Palmitic acid, rosemarinic acid
10.	*Allium sativum*	Leaves, bud	Acetyl-eugenol, Ascorbic acid, β -carotene, β-sitosterol, caryophyllene oxide, eugenol, isoeugenol
11.	*Zingiber officinalis*	Leaves, rhixome	Alanine, Ascorbic acid, β-sitosterol, Caffeic acid, Kaemferol, Methionine
12.	*Ginkgo biloba*	Plant	6-Gingerol,alanine, Ascorbic acid, Histidine, Lauricacid, Methionine, Myristic acid, Palmitic acid, Tryptophan EGB 761,Ginkgogolide
13.	*Vitis vinifera*	Fruit, seed	Alanine, α –pinene, ascorbic acid,β -Sitosterol, caffeic acid,
14.	*Citrus aurantifolia*	Fruit	Eugenol, Linalylacetate, Palmitic acid, Tannin
15.	*Cymbopogon citratus*	Leaves	B-sitosterol, Myrcene, Selenium
16.	*Commiphora myrrha*	Resin, sap	B-Sitosterol, campestrol, eugenol
17.	*Myristica fragnance*	Seed, leaf	Lauric acid, Myrcene, Palmitic acid
18.	*Olea europaea*	Leaf	A -tocopherol, apigenin, β -carotene, γ -tocopherol, kaempferol, Luteolin
19.	*Mentha piperata*	Leaf	Menthol, Limonene
20.	*Catharanthus roseus*	Leaf	Vincristine, Vinblastine
21.	*Rosemarionus officinalis* L.	Entire plant	Limonene,camphene,1,8-cineol
22.	*Santalum album*	Leaf, oleoresin	Beta-santalol, alpha-santalol

23.	*Curcuma domestica*	Fruit, wood	Xanthorrhizol, camphor
24.	*Acorus calamus*	Rhizome	Carsonic acid, Rosemaric acid, B –sitosterol , Caryophyllene oxide, eugenol, isoeugenol
24.	*Alisma plantago-aquatica* L.	Rhizome	Alanine, eugenol, β -sitosterol, Palmitic acid, phenol Curcumin, tannins, phenolic acids
26.	*Allium ursinum* L.	Flowering aerial parts	Only antioxidative fractions devoid of beta-asarone should be used, Triterpene (Alisol B)
27.	*Cotinus coggygria scop.*	Root	Flavonoids, sulfur-containing compounds
28.	*Angelica sylvestris* L.	Leaf	Flavonoids, sulfur-containing compounds
29.	*Anthriscus cerefolium*	Leaf	Flavones, aurones, chalcones
30.	*Anthriscus sylvestris*	Root, grains	Flavones, aurones, chalcones Flavonoids, coumarins
31.	*Carum carvi* L.	Root, flowering aerial part	Flavonoids (apiin), lignans Flavonoids (quercetin, apigenin)
32.	*Eryngium campestre* L.	Flowering aerial part	Flavonoids, volatile oil
33.	*Sanicula europaea* L.	Fruits	Flavonoids, triterpenes
34.	*Achillea millefolium s.* L.	Flowering aerial part	Rosmarinic acid derivative Flavonoids, tannins, volatile oil
35.	*Arctium lappa* L.	Flowering aerial part	Flavonoids
36.	*Artemisia absinthium* L.	Leaf, root	Flavonoids
37.	*Artemisia vulgaris* L.	Flowering aerial part	Flavonoids, glycosides
38.	*Bellis perennis* L	Flowering aerial part	Flavonoids
39.	*Bidens tripartite* L.	Flowering aerial part	Flavonoids
40.	*Carlina acaulis* L.	Flowering aerial part Root Flower	Phenolic acids, acidic polysaccharides with un precised structure Flavonoids
41.	*Carthamus tinctorius* L.	Flowering aerial part, root	Phenolic acids, flavonoids
42.	*Cinhorium intybus* L.	Leaf, Flowering aerial part	Phenolic acid, flavonoids polysaccharides (mucilage's)
43.	*Cirsium arvense* L.	Flowering aerial part	Flavone 6-C-Glycosides
44.	*Conyzacanadensis cronq.*	Flowering aerial part	Flavonoids, glucosinolats
45.	*Hieracium pilosella* L.	Flowering aerial part	Flavonoids
46.	*Marticaria recutita* L.	Root, Flowering aerial part	Flavonoids, procyanidins
47.	*Onopordum acanthium*	Leaf	Phenolic acid, flavonoides
48.	*Solidago virgaurea* L.	Leaf	carotenoids Flavonoids
49.	*Taraxacum officinale*	Flowering aerial part	Flavonoids
50.	*Tussilago farfara L*	Flowering aerial part	Flavonoids
51.	*Betula pendula Roth*	Flowering aerial part	Flavonoids
52.	*Alliaria petiolata*	Glandulae	Flavonoids, procyanidins
53.	*Capsella bursa pastoris*	Flowers	Flavonoids, procyanidins
54.	*Nasturtium officinale*	Leaf	Flavonoids
55.	*Humulus lupulus* L.	Branches	Flavonoids, phenolic acids
56.	*Sambucus nigra* L.	Branches	Flavonoids, phenolic acids
57.	*Sambucus ebulus* L.	Grains	Flavonoids, carotinoids
58.	*Viburnum lantana* L.	Fruits	Flavonoids
59.	*Viburnum opulus* L.	Grains,leaf,fruit	Triterpenes
60.	*Evonymus eurapaeus* L.	Fruits	Isoflavones
61.	*Cornus mas* L.	Fruits	Isoflavones
62.	*Corylus avellana* L.	Leaf, branch, Flowering aerial part	Tannins, procyanidins, flavonoids Isoflavones
63.	*Juniperus communis* L.	Flowering aerial part	Tannins, procyanidins, Flavonoids
64.	*Hippophae rhamnoides* L.	Flowering aerial part	Xanthones, phenolic acids Tannins, gallic acid
65.	*Elaeagnus angustfolia* L.	Flowering aerial part	Flavonoids, tannins
66.	*Equisetum arvense* L.	Flowering aerial part	Flavonoids
67.	*Calluna vulgaris* L.	Flowering aerial part	Flavonoids
68.	*Vaccinium myrtillus* L.	Flowering aerial part	Flavonoids, phenolic acids
69.	*Anthyllis vulneraria* L.	Flowering aerial part	Flavonoids
70.	*Genista tinctoria* L.	Flowering aerial part	Flavonoids, phenolic acids
71.	*Lotus corniculatus* L.	Flowering aerial part	Flavonoids, phenolic acids
72.	*Melilotus officinalis* L.	Flowering aerial part	Flavonoids
73.	*Ononis spinose* L.	Flowering aerial part	Flavonoids, phenolic acids
74.	*Trifolium arvense* L.	Bark, flowers	Flavonoids, phenolic acids
75.	*Trifolium pretense* L.	Bark	Flavonoids
76.	*Trifolium repens* L.	Flowering aerial part	Flavonoids, iridoids
77.	*Quercus petraea* L.	Flowering aerial part	Phenolic acids, flavonoids, carotenoids
78.	*Quercus robur* L.	Flowering aerial part	Polysaccharides, flavonoids
79.	*Centaurium erythraea* L.	Flowering aerial part	Polysaccharides (mucilage's), flavonoids
80.	*Erodium cicutarium geranium* L.	Flowering aerial part	Flavonoids, coumarins phenylpropanoids (verbascoside), Tannins

Commonly used herbal antioxidants

1. *Cocculus hirsutus*

In a step in this direction we have evaluated antioxidant potency of the ethanol extract on the aerial parts of *Cocculus hirsutus* Diels. The extract was investigated for its free radical scavenging action to wards 1, 1-Diphenyl–2picryl hydrazyl, nitric oxide, superoxide and hydroxyl radicals and found that the ethanol extract shows promising free radical scavenging activity in dose dependent manner. This antioxidant potency may be related to the presence of antioxidant vitamins and phenolic compounds present in the extract. These results clearly indicate that *Cocculus hirsutus* Diels is effective against free radical mediated diseases.

Fig 1: *Cocculus hirsutus*

2. *Withania somnifera (Ashwagandha*)

Ashwagndha (*Withania somnifera*) belongs to Solanaceae family and has been used for centuries in Indian systems of alternative medicine to treat various ailments. It is commonly known as Indian Ginseng because of its comparable medicinal value to ginseng which is acclaimed for its activity in alleviating stress induced illness. The medicinal properties of ashwagandha are mostly attributed to its tuberous roots whose extracts are widely marketed as an over the counter herbal supplement. Adaptogens, like ashwagandha, are believed to facilitate the maintenance of homeostasis by normalizing physiological as well as biochemical changes induced by stress. The anti-inflammatory, anticancer and immunomodulatory activities of ashwagandha rationalize its extensive use in promoting longevity. Ashwagandha's antioxidant activity suggests that a common molecular mechanism may be responsible for its diverse biological effects.

Fig 2: *Withania somnifera*

3. *Zingiber officinale* (Ginger)

Ginger is a widely used herbal supplement, often used in a number of culinary preparations all around the world. It is a rhizome of the herb *Zingiber officinale*, which belongs to the family Zingiberaceae. Due to its diverse healing properties it is extensively used in alternative medicines such as Chinese medicine, Ayurveda, Siddha and Unani. The Indian systems of medicines recommend the use of ginger as a kaya karpam or rejuvenator. It is used both in fresh and dried form to treat nausea and vomiting, osteo and rheumatoid arthritis, diabetes mellitus, indigestion and some cardiovascular disorders. Various studies have demonstrated the anti-oxidant, anti- inflammatory, anti-cancer and anti-microbial properties of ginger. These multiple biological properties of ginger support its clinical application as an herbal rejuvenator.

Fig 3: *Zingiber officinale* (Ginger)

4. *Azardirachta indica* (Neem)

Azardirachta indica, commonly known as neem, belongs to the family Meliaceae, is a large ever green tree with immense medicinal applications. Various parts of the neem tree such as leaves, flowers, seeds, roots and bark are used as traditional remedies for a number of ailments in the Indian systems of alternative medicine. However, the wide ranging medicinal value of the neem leaves stands out in comparison with other parts of the tree. Various studies have indicated that the neem leaves have anti-microbi, anti-inflammatory, analgesic, antidiabetic, immune- modulatory, anti-oxidant and anti-cancer properties. Due to its numerous pharmacological activities neem leaves are used as a kaya karpam to promote longevity.

Fig 4: *Azardirachta indica* (Neem)

5. *Benincasa hispida*

The crude extracts of *Benincasa hispida* i.e. Methanolic extract (M.E.) and aqueous extract (A.E.) were studied for the presence and detection of phytochemical such as alkaloids, saponins, steroids, carbohydrates and flavonoids using standard procedures. On the basis of the results, the extracts were further used for *in vitro* evaluation of antioxidant activity. The present study was designed to study the phytochemical screening and to investigate the free radical scavenging potential of aqueous and methanolic extract of dried ripe peels of Benincasa hispida. The free radical scavenging potential was evaluated by DPPH (1.1,-diphenyl-2-picrylhydrazyl).

Fig 5: *Benincasa hispida*

6. *Sonchus asper*

Evaluation of phenolic contents and antioxidant activity of various solvent extracts of *Sonchus asper* (L.) HilL. The SA extracts presented a remarkable capacity to scavenge all the tested reactive species with IC50 values being found at the µg ⁄ ml leveL. The SAME was shown to have the highest TPCs while lowest IC50 values for the DPPH•, ABTS •+radical scavenging capacities and iron

Chelating scavenging efficiency, moreover, SAME had best activities in scavenging of superoxide radicals and hydrogen peroxide as well as potently scavenged the hydroxyl radicals. These results suggest the potential of S. asper as a medicine against free radical-associated oxidative damage.

Fig 6: *sonchus asper*

7. *Moringa oleifers*

To assess the phytochemical constituents, total phenolic content, cytotoxicity and in-vitro antioxidant activity of stem bark extracts of Moringa oleifera (*M. oleifera*) (Moringaceae). Brine shrimp lethality (BSL) bioassay was used to investigate the cytotoxic effects. DPPH and nitric oxide radical scavenging activity was used to demonstrate antioxidant activity.

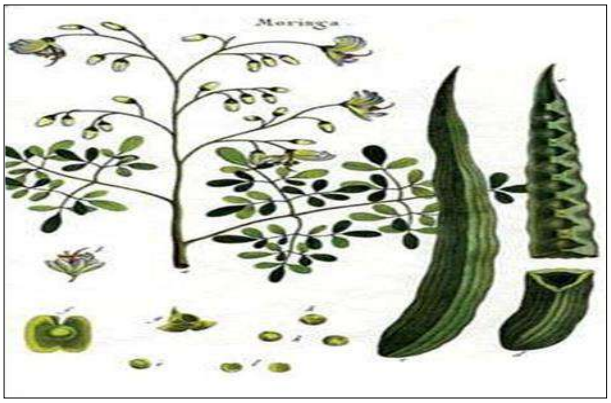

Fig 7: moringa oleifera

8. *Momordica charantia*

The aim of the present study was to investigate the *in vitro* antioxidant activity of aqueous and methanol extracts of Momordica charantia leaves. The antioxidant activity of the plant was also Determined BT DPPH and ABTS methods using ascorbic acid and gallic acid as standards respectively.

Fig 8: *Momordica charantia*

9. *Asparagus racemosus*

It shows antioxidant activity through the free radical scavenging, superoxide anion radical scavenging, hydrogen peroxide scavenging, nitric oxide scavenging, metal chelation, reduction power and inhibition of lipid peroxidation in rats. Its chemical constituents are saponins (Shatavarin I-V), alkaloids, polyphenols, flavonoids, vitamin C.

Fig 9: Asparagus racemosus

10. *Glycyrrhiza glabra*

It is popular as licorice 'yastimadhu'. Its extract was tested by studying the inhibition of radiation induced lipid peroxidation in rat liver microsomes. Chemical constituents are glycyrrhizin, flavones, and coumarins. It shows its activity through free radical scavenging property. Its other actions are diuretic, demulcent, tonic etc.

Fig 10: Glycyrrhiza glabra

11. *Origanum dictamnus*

The aqueous extract scavenges free radicals generated by the fenton reaction and reducing oxygen consumption of a methyl linoleate emulsion. The active components of herb are phenolic compounds, mainly flavonoids and phenolic acids.

Fig 11: Origanum dictamnus

12. *Annona squamosal*

It is popular as 'Custard apple or Sitaphal'. Streptozotocin induced diabetic rats were used. It reduces the lipid peroxidation and increases the activity of antioxidant enzymes and strong super oxide radicals and singlet oxygen quenchers. Chemical constituents are flavonoids.

Fig 12: *Annona squamosal*

Conclusion

As antioxidant is a molecule capable of slowing or preventing the oxidation of other molecules. Oxidation is achemical reaction that transfers electron from a substance to an oxidizing agent. Oxidation reactions can produce free radicals, which start chain reactions that damage cells. Antioxidants are the substances that inhibit oxidation and are capable of counteracting the damaging effects of oxidation in body tissue. They prevent damage caused by free radicals. Free radicals are very unstable molecules with an unpaired electron and are important intermediates in natural processes involving control of vascular tone, cytotoxicity and neurotransmission. Free radicals cause many human diseases like cancer, Alzheimer's disease, cardiac reperfusion abnormalities, kidney disease and fibrosis etc. Antioxidants play many vital functions in a cell and have many beneficial effects when present in foods.

Current research reveals the different potential application of antioxidant/free radical manipulations in prevention or control of diseases. Natural products from dietary components such as Indian species and antioxidant status and, therefore, the normal physiological medicinal plants are known to possess antioxidant activity. Increasing intake of dietary antioxidants may help to maintain an adequate function of a living system. To protect the cells and organ systems of the body against reactive oxygen species, humans have evolved a highly sophisticated and complex antioxidant protection system.

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