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ANTIOXIDANT PHYTOCHEMICALS AND SOME RESEARCH ON PLANTS- A REVIEW

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ABSTRACT

Free radicals are produced in the body by natural biological processes or introduced from outside like stress, insomnia, some pollution of air, smoking, taking fast food that can damage cells, proteins, and DNA by altering their chemical structure. The consequent effect of free radicals is premature aging, degenerative diseases, diabetes, and cancer etc. Antioxidant is such molecules which prevent free radicals intermediates and inhibits other oxidation. Plants are one of the main natural sources to prevent free radicals and it is scientifically proved. Plants contain antioxidant phytochemicals like Phenolic acid, Flavonoids, Carotenoids, Tannic acid, Ascorbic acid, Vitamin A, E etc. Some plants found that rich of antioxidant like *Morigna oleifera*, Carrot, Guava, Beet root, Amla, Berry, Black tea. In this review article some evidence based information of the antioxidant phytochemical and effect of antioxidant properties of plants is described.

KEYWORDS: Free radicals, Antioxidant, phytochemicals and plants.

INTRODUCTION

Free radicals are atoms or molecules containing one or more unpaired electrons, making them very "reactive". Biologically relevant free radicals are activated atoms or groups of atoms (usually containing oxygen or nitrogen) with an odd (unpaired) number of electrons. In a non-radical compound, all orbits are occupied by two electrons. When a chemical reaction breaks the bonds that hold paired electrons together, free radicals are produced. Therefore in a 'free radical' compound, there is a single unpaired electron in the outer orbit. A single excited electron is searching to become part of a paired set and will steal an electron from another, nearby atom to accomplish this pairing. During this theft, the original free radical becomes stable while the neighboring atom, by losing an electron, becomes a free radical itself. This new free radical will then seek out another atom to steal from, creating a chain reaction. The extreme reactivity driven by a desire to acquire another electron underlies their ability to interact with and ultimately damage tissue. Biologically relevant molecules such as DNA, proteins, lipids and carbohydrates are damaged.[1]

The free radicals may be either Reactive Oxygen Species (ROS) or Reactive Nitrogen Species (RNS). The most common reactive oxygen species include superoxide anion (O2), hydrogen peroxide (H2O2), peroxyl radicals (ROO) and reactive hydroxyl radicals (OH). Reactive Nitrogen Species of free radicals are nitric oxide (NO), peroxy nitrite anion (ONOO), Nitrogen dioxide (NO2) and Dinitrogen trioxide (N2O3). 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.[2]

Oxidative stress has the potential to damage cells and may eventually lead to cancer, cardiovascular diseases, diabetes, aging, and a vast number of other illnesses and disorders.[3] Antioxidant phytochemicals play a key role in oxidative stress control and in the prevention of related disorders, such as premature aging, degenerative diseases, diabetes, and cancer.[4]

Antioxidants are compounds that can prevent or delay the oxidation of oxidizable products by scavenging free radicals and reducing oxidative stress. Oxidative stress is an imbalanced state where excessive quantities of reactive oxygen and/or nitrogen species overshadow the endogenous antioxidative capability of the cells which stimulates the oxidation of macromolecules, such as proteins, enzymes, lipids and DNA.[5]

Exogenous antioxidant from natural compounds , i.e., curcumin, baicalen, and resveratol prevent arthrosclerosis formation by exhibiting radical scavenging effects. A number of flavonoids, including quercetin, morin, gossypetin, chrystin, myrecetin, rutin, catechin, and its derivatives and some oligomeric proanthocyanidins are reported to inhibit the oxidation of LDL in in vitro studies.[6]

Antioxidant phytochemicals

Phenolic compounds

Phenolic compounds are biologically active secondary metabolites from plants that act at molecular level and are potent natural antioxidants.[7]

The antioxidative properties of phenolic compounds have been analysed and achieved via three main mechanisms: I. Scavenging radical species (for removing impurities) such as reactive oxygen species (ROS) and reactive nitrogen species (RNS). II. Suppression of ROS/RNS synthesis by inhibiting specific enzymes or chelating trace metals involved in free radical generation. III. Up-controlling or inhibition of antioxidant defense system.[5]

Phenolics possess a wide spectrum of biochemical activities such as antioxidant, antimutagenic, anti carcinogenic as well as ability to modify the gene expression. Phenolics are the largest group of phytochemicals that account for most of the antioxidant activity in plants or plant products.[8] Plant phenolics mainly consist of phenolic acids, flavonoids, anthocyanins and their glycosides.[9]

Phenolic acid

Phenolic acids belong to a group of natural products which originate from several cereals and fruits. Higher concentrations of this compound are found at the superficial layers of the kernel which set-up the bran. As a group, phenolic acid have been found as strong antioxidants against the negative influence of free radicals and ROS, which is the basis of several chronic human diseases [10]. Certain red fruits contain high amount of phenolic acids like blackberries which contain up to 270 mg/kg fresh weight.[11]

Flavonoids

Flavonoids are the largest group of naturally occurring phenolic compounds, which occurs in different plant parts both in free state and as glycosides. They are found to have many biological activities including antimicrobial, mitochondrial adhesion inhibition, antiulcer, antiarthritic, antiangiogenic, anticancer, protein kinase inhibition etc.[12]

Flavonoids' antioxidative capacity influences different metabolic mechanisms that includes free radical scavenging, metal ions chelation and enzymes inhibition responsible for free radical generation.[13,14]

Depending upon molecular structures, flavonoids are divided into six classes: flavones, flavanones, flavonols, isoflavones, anthocyanidins and flavanols (or catechins). Flavonols are the most ubiquitous flavonoids in foods. The major flavonols are quercetin and kaempferol. The richest sources of favonoids are onions (up to 1.2 g/kg fresh wt), then curly kale, leeks, broccoli and blueberries also contains a large amount of flavonoids. While the analysis of red wine and tea suggests that both contain up to 45 mg flavonols/L.[15]

Tannic Acid (Tannins)

Tannic acid is always used as a food additive. It's safe dosage ranges from 10 to 400 micro gm, depending on the type of food to which it is added.[16]

Tannic acid and other polyphenols have antimutagenic and anticarcinogenic activities. Moreover, the consumption of polyphenol rich fruits, vegetables and beverages, such as tea and red wine, has been linked with inhibitory and preventive effects in various human cancers and cardiovascular diseases, which may be related at least in part with the antioxidant activity of polyphenols.[17] Tannic acid exhibits antioxidant, antimutagenic and anticarcinogenic properties.[18]

Carotenoids

Carotenoids are yellow, orange or red pigments present in fruits and vegetables. A carotene, β-carotene, lycopene, lutein, and β -cryptoxanthin are associated with reduced risk of cardiovascular diseases. These compounds are generally divided into two classes, carotenes and xanthophylls.[19] β-Carotene (BC) is a naturally occurring orange-colored carbon-hydrogen carotenoid, abundant in yellow-orange fruits and vegetables and in dark green, leafy vegetables.[20] Carotenoids are efficient antioxidants protecting plants against oxidative damage. They are also part of the antioxidant defense system in animals and humans. Due to their unique structure it can be suggested that they possess specific tasks in the antioxidant network such as protecting lipophilic compartments or scavenging reactive species generated in photooxidative processes.[21]

Ascorbic acids (Vitamin C), A & E

Ascorbic acids play an important role in ameliorating the oxidative stress of photosynthesis. In addition, it has a number of other roles in cell division and protein modification. Ascorbic acid behaves not only as an antioxidant but also as a pro-oxidant.[22] Ascorbic acid has been shown to reduce transition metals, such as cupricions (Cu2+) to cuprous (Cu1+), and ferricions (Fe3+) to ferrous (Fe2+) during conversion from ascorbate to dehydroascorbate in.[23]

Vitamin C is a free radical scavenger and displays antioxidant activity. We focused on the potential preservative effects of vitamin C after lung injury. Generally, lung injuries can result in the generation of reactive oxygen species (ROS) by pulmonary endothelial cells, which leads to autooxidative damage.[24]

Vitamin C functions as an antioxidant and is necessary for the treatment and prevention of scurvy. Besides, a number of phytochemicals are present in plants which have their own mechanism of action for prevention and curing of diseases.[25]

Some vitamins possessing an antioxidant activity protect the cells from the damage caused by the free radicals and by preventing free radical formation they play an important role in the antioxidant defense. The most significant antioxidant vitamins are vitamins E, A and C (ascorbic acid) [26].

Among these smaller molecules, vitamin E and vitamin A, is regarded as the primary lipidsoluble antioxidant that operates synergistically with vitamin C to protect lipids against per oxidative damage.[27] Antioxidant vitamins such as vitamin A (i.e. beta carotene), C and E are part of the physiological non-enzymatic defense against oxidative stress.[28]

Total component of Nutrient (vitamins and minerals) with their functions are shown in table 1.

Table 1: Vitamins and minerals in antioxidant systems.[29]

Nutrients	Component (location in cell)	Function
Vitamin C	Ascorbic acid (cytosol)	Reacts with several types of ROS/RNS
Vitamin E	α-tocopherol (membranes)	Breaks fatty acid peroxidation chain reactions
β-carotene	β-carotene (membranes)	Prevents initiation of fatty acids peroxidation chain reaction
Selenium	Glutathione peroxidase (cytosol)	An enzyme that converts hydrogen peroxide to water
Copper and zinc	Superoxide dismutase (cytosol)	An enzyme that converts superoxide to hydrogen peroxide
Manganese and zinc	Superoxide dismutase (mitochondria)	An enzyme that converts superoxide to hydrogen peroxide
Copper	Ceruloplasmin (water phase)	An antioxidant protein, may prevent copper and iron from participating in oxidation reactions
Iron	Catalase (cytosol)	An enzyme (primarily in liver) that converts hydrogen peroxide to water

Some evidence based phytochemical found in various plants are given below.

Moringa oleifera

Antioxidant activity was determined by analysing the total phenolics content, total flavonoids content, reducing power and radical scavenging activity. The total phenolics content of moringa was almost twice that of the vegetables and the total flavonoids content was three times that of the selected vegetables. The reducing power of moringa was higher than that of the vegetables and the percentage of free radicals remaining was lower compared with the vegetables. These results combined show that moringa is a good source of antioxidants.[30]

Moringa oleifera have been evaluated for its antioxidant activity. *M. oleifera* leaves were extracted with methanol, ethyl acetate, dichloromethane and n-hexane. The methanol extract showed the highest free radical scavenging activity. This study provided that M. oleifera leaves possess antioxidant.[31]

Guava

The phenolic content and antioxidant activity of grape (*Vitis vinifera*) seed powder extracted by in vitro physiological procedure and chemical procedure were investigated. The in vitro physiological procedure yielded a higher phenolic content and antioxidant capacity than the chemical procedure.[32]

Antioxidant activities of grape seeds from pekmez production determined. These values were twice higher than those from winery byproducts. Flavonoid content of grape seeds from pekmez production was 49.2 mgcatechin equivalent per gram dry matter, and this was twice higher than that of winery waste. This study indicated that in terms of phenolic content and antioxidant activity, byproduct grape seeds of pekmez production are more valuable than those of winery waste.[33]

Berries

Berries, especially members of several families, such as Rosaceae (strawberry, raspberry, blackberry), and Ericaceae (blueberry, cranberry), belong to the best dietary sources of bioactive compounds (BAC). The bioactive compounds in berries contain mainly phenolic compounds (phenolic acids, flavonoids, such as anthocyanins and flavonols, and tannins) and ascorbic acid.[34]

Raspberry and blackberry cultivars were assayed for antioxidant activity, 10 anthocyanins and anthocyanidins were determined in raspberry and blackberry. Raspberry and blackberry had the highest ABTS, DPPH, CUPRAC, total phenol, and total flavonoid contents in methanol extracts, whereas total anthocyanin contents were the highest in water extracts. The antioxidant activity of the raspberry and blackberry was directly related to the total amount of phenolic compounds detected in the raspberry and blackberry.[35]

Carrot

Carrot (Dascus carota L.) is rich in beta carotene, ascorbic acid, tocopherol and classified as vitaminized food. Combination of carrot juice and yoghurt produce a nutritionally balanced food. The carrot soyghurt produced from 15% carrot juice and 16 hours fermentation were accepted of panelists, having 140 of taste score, 104 of flavour score, 118 of color score and 94.5 of viscocity, 6.52% of protein content, 1.51% of fat content and 52.49% of activity antioxidant.[36]

Phenolic compounds, their antioxidant properties and distribution in carrots were investigated in this study. Carrots contained mainly hydroxycinnamic acids and derivatives. Among them chlorogenic acid was a major hydroxycinnamic acid, representing from 42.2% to 61.8% of total phenolic compounds detected in different carrot tissues.[37]

Amla

Amla is well-known for its rich vitamin C (ascorbic acid) and polyphenol contents. To assess its antioxidant activity, we examined aqueous amla extract. It was observed that the amla extract acts as a very good antioxidant against g g-radiationinduced LPO. Similarly, it was found to inhibit the damage to antioxidant enzyme SOD.[38]

Aqueous and alcoholic extracts of amalki (Emblica officinalis), spirulina and wheatgrass were prepared and analyzed for antioxidant vitamin content (vitamin C and E), total phenolic compounds. Antioxidant status, reducing power and effect on glutathione S-transferase (GST) activity were evaluated in vitro. Vitamin C content of crude amlaki powder was found to be 5.38 mg/g, while very less amount 0.22 mg/g was detected in wheat grass. Amalki was rich in vitamin E like activity, total phenolic content, reducing power and antioxidant activity. Total antioxidant activity of aqueous extract of amalki, spirulina and wheat grass at 1mg /ml concentration were 7.78, 1.33 and 0.278 mmol/l respectively. At similar concentrations the total antioxidant activity of alcoholic extract of amalaki, spirulina and wheat grass was 6.67, 1.73 and 0.380 mmol/l respectively. Amalki was also found to be rich source of phenolic compounds.[39]

Green tea

Tea (Camellia sinensis) is one of the most widely consumed beverages in the world. Tea extracts are source of polyphenols, which are antioxidant components. Green tea phenolic compounds are predominately composed of catechin derivatives, although other compounds such as flavonols and phenolic acids are also present in lower proportion.[40]

To trace out the presence of antioxidant in *Camellia sinensis* leaves. The total phenoloic content was 0.8 grams in per gram of leaf extract while the flavonoid content was 16mg per gram of leaf extract. Reducing power of Camellia sinensis was 0.13grams in per gram of leaf extract. The antioxidant activity was 70% in per gram of leaf extract. The methanol extract of Camellia sinensis showed highest antioxidant activity 325.76±0.14mg than the ascorbic acid with 298. 98±0.14mg.[41]

Ginger

The study was designed to evaluate the chemical composition and antioxidant activity of ginger (*Zingiber officinale*) and cumin (*Cuminum cyminum*). The DPPH method showed the highest antioxidant activity for cumin essential oil (85.44 +/- 0.50%) followed by dried ginger essential oil (83.87 +/- 0.50%) and fresh ginger essential oil (83.03 +/- 0.54%). Their results suggest that both ginger and cumin can be used as potential sources of natural antioxidants in foods.[42]

Beetroot

Pressed juices and water extracts from untreated, microwave pretreated and thermally treated red beet were obtained. The antioxidant activity of the pressed juices and extracts was determined. The highest antioxidant activity - 10832.4 μmol TE/L has shown the pressed juice obtained from microwave pretreated red beet. Different variants of mixed beverages using chokeberry, blackberry, blueberry and black currant were obtained in which the concentration of the red beet pressed juice was 25%, 50% and 75%. Their polyphenol content and antioxidant activity were determined. The highest antioxidant activity has shown mixed pressed juice from red beet and chokeberry [43].

Beetroot ingestion provides a natural means of increasing in vivo nitric oxide (NO) availability. Beetroot is also being considered as a promising therapeutic treatment in a range of clinical pathologies associated with oxidative stress and inflammation. Its constituents, most notably the betalain pigments, display potent antioxidant, anti-inflammatory and chemo-preventive activity in vitro and in vivo [44].

CONCLUSIONS

Plant contains a lot of antioxidant phytochemical which is very effective to inhibit free radical activities and prevent cell and tissue damage, altering of DNA etc. It is scientifically proved that usage of antioxidant plants can prevent free radicals and protect from premature aging, degenerative diseases, diabetes, and cancer.

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