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Review Article

BIOLOGICAL SCAVANGERS OF FREE RADICLES -ANTI-OXIDENTS: A Review

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ABSTRACT:

Present article gives a holistic view of the causes, role and control of oxidative stress in the development and progression of various human diseases. Several types of reactive species are generated in the body as a result of metabolic reactions in the form of free radicals or non-radicals. These species may be either oxygen derived or nitrogen derived and called pro-oxidants. They attack macromolecules including protein, DNA and lipid etc. causing cellular/tissue damage. To counter their effect, the body is endowed with another category of compounds called antioxidants. These antioxidants are produced either endogenously or received from exogenous sources and include enzymes like superoxide dismutase, catalase, glutathione peroxidase and glutathione reductase, minerals like Se, Mn, Cu and Zn, and vitamins like vitamin A, C and E. Other compounds with antioxidant activity include glutathione, flavonoids, bilirubin and uric acid etc.. In a healthy body, pro-oxidants and antioxidants maintain a ratio and a shift in this ratio towards pro-oxidants gives rise to oxidative stress. This oxidative stress may be either mild or severe depending on the extent of shift and remains the cause of several diseases such as cardiovascular diseases, neurological diseases, malignancies, renal diseases, diabetes, inflammatory problems, skin diseases, aging, respiratory diseases, liver diseases and different types of viral infections. As more and more reports are pouring in, a lot of information is being unfolded about oxidative stress in relation to several other diseases.

KEYWORDS:

Anti-oxidants, Oxidative stress, Pro-oxidants, Free radical.

INTRODUCTION:

When life forms on earth changed from using anaerobic source of energy to using oxygen we paid a big price in terms of toxic byproduct called free radicals. All of these cause severe cellular and DNA damage. Contributing to more than 60 other health conditions including:

- Increased ageing of bone, organ, brain and skin
- Interference with cell replications
- Malignant tissue formation
- Enzyme malfunctioning
- Atherosclerosis and heart diseases

One only defense in this war against free radicals are compound called antioxidant. It is generally recognized that antioxidant have the ability to serve as sort of a rust protector for the body.

Free radicals:

Free radicals form when oxygen is metabolized or formed in the body and are chemical species that possess an unpaired electron in the outer (valence) shell of the molecule. This is the reason why free radicals are highly reactive and can react with proteins, lipids, carbohydrates and DNA. These free radicals attack the nearest stable molecule, stealing its electron. When the attacked molecule loses its electron, it becomes a free radical itself, beginning a chain reaction, finally resulting in the disruption of a living cell.[2] Free radicals may be either oxygen derived (ROS, reactive oxygen species) or nitrogen derived (RNS reactive nitrogen species). The oxygen derived molecules are O_2 [superoxide], HO [hydroxyl], HO_2 [hydroperoxyl], ROO [peroxyl], RO [alkoxyl] as free radical and H_2O_2 [hydrogen peroxide], HOCl [hydrogen peroxide], HOCl [hypochlorus acid], O_3 [ozone] and O_2 [singlet oxygen] as non-radical. Nitrogen derived oxidant species are mainly NO [nitric oxide] ONOO [peroxy nitrate], NO_2 [nitrogen dioxide] and N_2O_3 [dinitrogen trioxide][9].

i. Cause of Free radical Generation:

Free radicals are formed as a part of body's normal metabolic processes. Synthetic (Xenobiotics) chemicals, radiations, X-rays, pollution and even stress can produce these damaging entities. The chemical known to produce free radicals include chlorinated hydrocarbon, aromatic hydrocarbon, industrial acids, more pesticides, preservatives inputs, printing pigments and ink and other industrial chemicals. Fragrance and perfumes, cosmetic vehicles, and cosmetics. Pollutant in air and water many if not all pharmacological agent used in medicine and anesthetic which has a profound effect in producing

radicals in the central nervous system. Even the transitional metal catalyst, iron and copper which is ubiquitous has a most powerful generating effect on chain initiating radicals.[4] Chemical mobilization of fat store under the various conditions such as lactation, exercise, fever, infection and even fasting can result increased radical activity and damage in particular to the immune and nervous system. Under conditions of continuing and excessive emotional stress, higher levels of the hormones adrenalin and nor adrenalin secreted by adrenal gland. As a natural part of their metabolic processing these stress hormone are oxidized to simpler molecules and in doing so becomes free radicals. It is possible through this increased production of hormone metabolite radicals that stress increased biological degenerative process occur. Resulting in wide spread of molecular, cell and tissue damage.[2,3] In the living organism, free radicals chain reactions are produced. Normally in the mitochondrial respiratory chain. Liver mixed function oxidase by bactericidal leucocytes, through Xanthine oxidase activity.[5]

Antioxidant:

To counter the harmful effects of free radicals like Reactive oxygen species (ROS) and Reactive nitrogen species (RNS), antioxidant defense mechanism operates to detoxify or scagenge these ROS and RNS. Antioxidants, together with the substances that are capable of either reducing Reactive oxygen molecules (RMSs) or preventing their formation, form a powerful reducing buffer and affect the ability of the oxygen metabolites'. All reducing agents, thereby form protective mechanisms, which maintain the lowest possible level of ROMs in the cell.[4]

Some of the reaction in the body that produces free radical involves metal ions. Some antioxidants such as tannins in walnut and tea, chelate metal ions. This not only reduces the formation of ion dependent free radicals but also prevents the metal ions from oxidizing cell and bio chemical directly.

By destroying free radicals and reducing cellular damage antioxidant as a group can:

- Promote eye health and prevent macular degeneration, cataract and other degenerative eye diseases. The benefits of antioxidant were examined during the age related eye disease study.
- Keep the immune system in good shape, or boost the immune system when it has been compromised
- Prevent age related neurodegeneration such as decline of the brain and nerve system.
- Prevent DNA damage and there for have ant carcinogenic effect
- Have antiatherogenic effect that is promote cardiovascular health and help prevent atherosclerosis, heart attack, strokes and other cardio vascular diseases

Antioxidants can decrease LDL and cholesterol, increase high density lipo protein HDL, and lower blood pressure[9.]

i. Role of Antioxidants:

Antioxidant defense system against oxidative stress is composed of several lines, and the antioxidants are classified into four categories based on function as follows:

- First line of defense is the preventive antioxidants, which suppress formation of free radical (enzymes such as glutathione peroxidase, catalase, superoxide dismutase; cartoneoids, selenoprotein, lactoferrin etc.)
    - Second line of defense is the radical scavenging antioxidants suppressing chain initiation and/or breaking chain propagation reactions, i.e., radical scavenging antioxidants.
- Third category antioxidants are repair and denovo antioxidants (some proteolytic enzymes repair enzymes of DNA, etc.).
    - Fourth line is an adaptation where the signal for production and reactions of free radicals induces formation and transport of the appropriate antioxidant to the right site.

Antioxidants act as radical scavenger, hydrogen donors, electron donor, peroxide decomposer, singlet oxygen quencher, enzyme inhibitor, synergist and metal chelating agents.

Classification of Antioxidants:

1. Enzymatic antioxidants
2. Non Enzymatic antioxidants

The first lines of defense against O_2^- and $H_2O_2^-$ mediated injury are antioxidant enzymes like SOD, GPx and CAT.

1. Enzymatic Antioxidative:

a. Superoxide dismutase (SOD)

Superoxide dismutase (SOD) is a family of metallo-enzymes that convert O_2^- and $H_2O_2^-$ by the reaction:

It is considered to be stress protein, which is synthesized in response to oxidative stress. SOD is the most important enzyme as it is found in all aerobic organisms and is also present in mitochondria and cytosol. There are four families of SODs: Cu-SOD,

Cu-Zn-SOD, Mn-SD and Fe-SOD enzyme and has been detected in a large number of tissues and organisms, and is thought that it is present to protect the cell from damage caused by $O_2^{\cdot -}$.

Increased plasma level of SOD has been reported in various diseases. Breast cancer patients have been reported to possess increased levels of plasma copper and zinc. Thus, increased production of SOD in various genetic diseases may be in response of higher production of free radicals in those diseases.

b. Glutathione peroxides' (GPx)

Glutathione peroxidase (GPx) is a selenium containing enzyme, which catalyses the reduction of H_2O_2 and lipid hydro peroxide (LO2H), generated during lipid peroxidation, to water using reduced glutathione as substrate. It is found in both cytosol and mitochondria and is a well-known first line of defense against oxidative stress, which in turn requires glutathione as a cofactor. It is involved in the generation of nucleotide precursors of DNA via the reduction of ribonucleotides to deoxyribonucleotides. GPx catalyses the oxidation of reduced glutathione (GSH) to oxidized glutathione (GSSG) at the expense of H_2O_2, by its selenium dependency. Since, selenium is an integral component of GPx, the measurement of this enzyme has been used as a functional index of selenium level.Low levels of selenium have been associated with a high risk of cardiovascular diseases and cancer in humans. Plasma GPx activity was found to be significantly elevated with respect to the controls in breast cancer patients. The reason of higher GPx activity in breast cancer patients may be in response to higher production of ROMs.

c. Catalase (CAT)

Catalase (CAT) is present in most cells and catalyses the decomposition of hydrogen peroxide to water and oxygen. The mechanism of action is as follows:

$2H_2O_2 \rightarrow 2H_2O + O_2$

CAT is found to act 104 times faster than peroxides and is mainly localized in mitochondria and in sub cellular respiratory organelles. CAT is found to be important in the inactivation of many environmental mutagens. Plasmid DNA strand scission caused by xanthenes/xanthenes oxidase (XO) has been reported to be prevented by both SOD and CAT enzymes. It also has a role in preventing chromosomal aberrations. The activity of CAT is found to be less when compared to SOD and GPx. In addition to the above enzymes, glutathione transferase, ceruloplasmin, hemoxygenase and possibly several other enzymes may participate in enzymatic control of oxygen radicals and their products.

2. Non enzymatic Antioxidative:

a. Antioxidant vitamins:

Antioxidative vitamins have a number of biological activities such as immune stimulation, inhibition of nitrosamine formation and an alteration of metabolic activation of carcinogens. They can prevent genetic changes by inhibiting DNA damage induced by ROMs. They protect the somatic cell from free radicals that are thought to be responsible for wide range of diseases.

i. Vitamin A

This fat-soluble vitamin is essential for growth, maintenance of visual function, reproduction and differentiation of epithelial tissue. They include the compounds -retinol and its esters, retinoldehyde and retinoic acid. Beta-carotene protects dark green, yellow and orange vegetables and fruits from solar radiation damage and plays a similar role in human body. It is an excellent scavenger of singlet oxygen ' produced during photosensitivity. It is reported to play a vital role in suppressing carcinogenesis by increasing immunity to tumours through several mechanisms. Vitamin A deficiency has been associated with a higher incidence of cancer. Studies have shown that low dietary intake of Vitamin A was correlated with the increased incidence of mortality from lung or breast cancer24. Vitamin A and its metabolites play a crucial role in regulating the differentiation and proliferation of epithelial cells. Both natural and synthetic analogues of vitamin A have been shown to be effective in various diseases. Carrots, squash, sweet potatoes, peaches, kale and apricots are rich sources of carotene.

ii. Vitamin C

Vitamin C is an important water-soluble antioxidant in biological fluids and an essential micronutrient required for normal metabolic functions of the body. It interacts directly with radicals like O_2^- and HO in plasma, thus preventing damage to cell membrane. Probably the n widely used of all vitamin supplements, vitamin C powerful antioxidant that has a myriad of functions and helps strengthen the immune system.

Many clinical studies show vitamin C is superior to over-the-counter medicines in reducing the symptoms, duration and severity of colds. As an antioxidant. it helps in cardiovascular disease by protecting the linings of arteries from oxidative damage. It neutralizes ROMs and reduces oxidative DNA damage and genetic mutations . The vitamin is plentiful in citrus fruits, green vegetables. raw cabbage and tomatoes.

iii. Vitamin E

Vitamin E is a lipid soluble vitamin. It occurs in plasma as a variety of tocopherols. most important being alpha-tocopherols. It scavenges peroxy radical intermediates in lipid peroxidation and is responsible for protecting PUFA (Poly unsaturated fatty acid) present in cell membrane and low-density lipoprotein (LDL). Against lipid per oxidation. In addition to its peroxyl radical scavenging properties, further interactions with ROS have been reported, including the quenching of singlet oxygen and the reaction with peroxynitrite. Compared to other lipophilic antioxidants, it is probably the most efficient antioxidant in the lipid phase. Its effectiveness is magnified when taken with other antioxidants, especially vitamin C, selenium and beta carotene. Sources of vitamin E include wheat germ oil, nuts, seeds, whole grains, vegetable oil and fish liver oil.

In addition to the "big three" Vitamins as discussed above, there are numerous small molecules that function as antioxidants. Examples include bilirubin, uric acid, and carotenoids[9,10].

b. Antioxidant Plants:

Live forms living in the Earth's atmosphere must be equipped with systems to deal with the action of oxygen in living matter. Plants are especially susceptible to damage by active oxygen exposed to radiation, UV light'. That is why plants have developed numerous antioxidant defense systems that have resulted in certain numbers of very potent antioxidants. Beside plants, many of microbial and animal products as well as fermented products, seaweeds and protein hydrolysates were found to be powerful antioxidants.[8]

Many plant products are known to exert antioxidative effect by quenching various free radicals. Normal diets, which are from natural sources consumed by the human population, have antioxidative agents. Among numerous plant antioxidants, the following plant secondary products are of particular interest

- Plant phenolics: Phenylproponoids, Coumarins, Flavonoids.
- Nitrogen containing compounds: Alkaloids, Nonprotein, Aminoacids, Isothiocvanate. Indoles.
- Phytosterols
- Carotenoids

Several antioxidants of plant origin are experimentally proved and used as effective protective agents against oxidative stress. Some of them are given below: The active principles of Withania somnifera were found to increase the concentration of antioxidant enzymes, SOD, CAT and GPx.. Ocimum leaves have significant activity in inhibiting the OH radical induced deoxyribose degeneration. Piperine, a major constituent from black and long pepper, enhances the synthesis of glutathione (GSH), which is known to inhibit or scavenge the free radicals.

Alcoholic extract of Brahmi was found to reduce lipid peroxidation induced by $FeSO_4$ and Cunene hydro peroxide. Andrographis paniculata activate antioxidant enzymes, thereby protecting the tissues from free radicals. Leaf extracts of Aloe Vera, Aglaia roxburghiana, Alliums sativum, Azadirachta indica, Emblica officinalis, Glycyrrhiza glabra, Tinospora cordifolia, etc are some other plants which have been reported to have antioxidant activity. Antioxidant activity of plants is found to be associated with phenols, flavonoids, xanthenes, alkaloids, anthraquinones and Steroids, etc. They exert their action through scavenging, "free radicals and inhibiting peroxidation

Oxidative stress:

In a normal cell, there are appropriate oxidant: anti-oxidant balance. However, this balance can be shifted, when production of oxygen species is increased or when levels of antioxidants are diminished. This state is called oxidative stress. Oxidative stress results in the damage of bioplymers including nucleic acids, proteins, polyunsaturated fatty acids and carbohydrates. Lipid per oxidation is oxidative deterioration of polyunsaturated lipids and it involves ROS and transition metal ions. It is a molecular mechanism of cell injury leading to generation of peroxides and lipid hydro peroxides, which can decompose to yield a wide range of cytotoxic products, most of which are aldehydes, like malondialdehyde (MDA), 4-hydroxynonenal (HNE), etc[8].

Oxidative stress causes serious cell damage leading to a variety of human diseases like Alzhaminer's diseases, Parkinson's diseases, artherosclerosis, cancer, liver damage, rheumatoid arthritis, immunological incompetence, neurodegenerative disorders, etc. nutritional antioxidant deficiency also leads to oxidative stress, which signifies the identification of natural ant oxidative agents present in diets consumed by human population.[6]

Antioxidants Therapy:

1. Antioxidants and Alzheimer's:

In Alzheimer's free radical are suspect for several reason. They attack phospholipids the molecules of fat

in neuron membrane. Some Researchers hypothesize that free radial upset the delicate membrane machinery that regulates what was into an out of the cell such as calcium. Free radicals may also have a connection with beta amyloid. One study has found that in neurotic plaques beta amyloid breaks easily into fragments, releasing free radicals.

The body has certain line of difference against oxygen free radicals. Enzymes like superoxides dismutase (SOD) and catalase can disarm the damaging oxygen molecule. And the vitamin in food known as antioxidants vitamin C and E and beta carotene which is related to vitamin A also counters free radicals. Acetyl- L carnitine may also show Alzhemiers by reducing the production of free radical.

2. Antioxidants and cataract:

Protein in the lens of the eye is highly susceptible to photo oxidation and thus the production of cataract. Vitamin C and E and the carotenoid are associated with delayed development of certain form of cataract. Improvement of vision is also positively associated with elevated level of these antioxidants. The consumption of 400 unit of vitamin E per day has about a one third the risk of cataract development.

3. Antioxidants and Diabetes:

In type I diabetes hyperglycemia results in the intra cellular accumulation of sorbitol produced by action of aldose reductase on glucose. Sorbitol may contribute to the complication of diabetes. The use of inhibitor of the enzyme aldose reductase appear to therapeutically promising. Vitamin C is an effective aldose reductase inhibitor and thus vitamin C may be helpful for therapeutic intervention in diabetes. The supplementation of pharmacologic dose 900 mg of vitamin E per day appeared to be a beneficial tool in reducing oxidative stress and improving insulin action.[11]

4. Antioxidants and Thrombosis:

Lipid peroxides and vitamin E deficiency reduces the production of prostacyclin. The body's most potent platelet stabilizing agent. Prostacyclin plays a role in retarding the progression of atherosclerosis. It is now known that oxidized. LDL also plays a role in atherosclerosis and vascular diseases. And vitamin E is an important nutrient in reducing the oxidation of lipid. Vitamin E reduces platelet adhesivness and plasma clotting time are increased using 300 unts per day vitamin E for upto 18 weeks. 2 gm of vitamin C per day significantly reduces the response of platelet aggregatory agent.

5. Antioxidants and Asthma:

Because of large surface area the respiratory tract is the major target for the free radical activity. Air pollution is the major source ROS. Recent studies suggested that free radicals may be involved in the development of pulmonary disorders such as asthma. Cellular damage caused free radicals is thought to be partially responsible for the bronchial inflammation characteristics of the disease. It has been suggested that increase in antioxidant intake may help in reducing oxidative stress and help to prevent and minimize the development of asthmatic symptoms. Vitamin C, E and beta carotenoid associated with improve pulmonary function. Glutathione and possibly N acetyl cystein which is the precursor to glutathione may be helpful in protecting against the pulmonary damage.[11,]

6. Antioxidants and Toxic Chemicals:

The consumption of alcoholic beverages is known to cause acute and/or chronic toxicity to a number of tissues including those of the nervous system, liver, gastrointerstinal track and cardiovascular system. Ethanol is responsible for mytochondrial damage, hepatic lipid accumulation and oxidative damage to macromolecules. It has been demonstrated that this damage can be blocked to some extend by the use of nutritional antioxidants. Adriamycin is cardio toxic and some studies have shown that the use of vitamin E and selenium may reduce its toxicity without reducing its antitumour effect.

High tension of oxygen are potentially extremely toxic and powerful stimulator of free radical damage. Vitamin C has been shown to protect against drugs such as chemotherapeutic agents, digitalis, benzene, barbiturates, aspirin and a number of biological toxin including botulinum toxin, tetanus toxin[8].

7. Exercise and Antioxidants:

During exercise, oxygen consumption can temporarily increase by a factor of more than 10. This leads to a temporary large increase in the production of oxygen free radicals, resulting in increased cell damage contributing to muscular fatigue during and after exercise. The body uses antioxidants to reduce the amount of such damage. The inflammatory response that occurs after strenuous exercise is also associated with increased occurrence of free radicals, especially during the 24 hours after an exercise session. In this phase too, antioxidants in the body reduce the damage. The immune system response to damage done by exercise peaks 2 to 7 days after exercise, the period during which adaptation resulting in greater fitness is greatest. During this process, free radicals are used by

neutrophils in the immune system to identify damaged tissue. As a result, excessive antioxidant levels have the potential to inhibit recovery and adaptation mechanisms. There is a popular view that those who undertake vigorous exercise can benefit from increased consumption of antioxidants, but an examination of the literature finds support that this is the case only for certain antioxidants at certain levels, and some evidence that very large intake of some antioxidants may be detrimental to recovery from exercise. There is strong evidence that one of the adaptations that result from exercise is a strengthening of the body's antioxidant defenses, particularly the glutathione system, to deal with the increased oxidative stress It is possible that this effect may be to some extent protective against diseases which are associated with oxidative stress, which would provide a partial explanation for the lower incidence of major diseases and better health of those who undertake regular exercise.[9]

8. Preventing Skin Ageing:

Free radical theory states that age, mutation, and damage accumulate might be due to the reactive oxygen species that organism generate during aerobic metabolism. That is when oxygen is converted to energy by a cell, little molecules, called free radicals are produced. When these free radicals are produced in toxic amount they damage the cellular level of the body which can result in cell death and tissue damage.

Many of the skin preparation contain antioxidants. The most commonly used vitamin E, A, C and panthenol. Vitamin E (dl µ tocopherol) is employed as antioxidant showed 5% reduction of membrane phospholipids peroxidation. Peroxides are involved in the cellular damage caused during photo agents. Vitamin E acetate is used as an emollient in skin cream and gel.Vitamin A, retinoids have been most widely used in the treatment of photo damaged skin. Renova and emollient based form of tretinoin has received approval from FDA for cosmetic treatment of ageing skin. Structural improvement brought about by this material include normalizsation of epidermal activity, formation of new collagen and blood vessel, and reduction in pigmentory changes. Vit C is another natural antioxidant which regulate collagen biosynthesis and is involved in the wound healing process of the body. It also help to regulate vitamin E to its parent form and therefore its ability to scavenge free radicals.[11]

Oxygen free radical Absorbance Capacity:

We have developed a method called the oxygen radical absorbance capacity (ORAC) assay which depends on the unique properties of the protein, phycoerythrin (PE). The ORAC assay is, to date, the only method that takes reaction of the free radical reactive species to completion and uses an "area under the curve" (AUC) technique for quantitation, and thus combines both inhibition time and inhibition percentage of the reactive species action by antioxidants into a single quantity. The ORAC assay depends on the detection of chemical damage to R- or B-PE through the decrease in its fluorescence emission. The fluorescence of PE is highly sensitive to the conformation and chemical integrity of the protein. Under appropriate conditions, the loss of PE fluorescence in the presence of reactive species is an index of oxidative damage of the protein. The inhibition of the reaction by an antioxidant, which is reflected in the protection against the loss of PE fluorescence in the ORAC assay, is a measure of its antioxidant capacity against the reactive species. Lesser-known antioxidants such as lycopene, may reduce prostate cancer rates, and lutein, which is strongly associated with a decrease in age-related macular degeneration , and prostate cancer. Studies of high-risk groups, such as the nurses with heart disease, suggest the greatest benefit from increased consumption of antioxidants is realized by those at the greatest risk of disease.

Adverse effects of Antioxident Supplementation:

Relatively strong reducing acids can have anti-nutritional effects by binding to dietary minerals in the gastrointestinal tract and preventing them from being absorbed. Notable examples are oxalic acid and phytic acid, which are high in plant-based diets. Some tannin also have this negative characteristic. Calcium and iron deficiencies are not uncommon in mideastern diets where there is high consumption of phytic acid present in beans and unleavened whole grain bread. These anti-nutrients can result in deceptively high oxygen radical absorbance capacity (ORAC) ratings given to various "healthy" beverages and foods, particularly:

- cocoa/chocolate, spinach, and berries - oxalic acid
- whole grains, maize - phytic acid
- tea - tannins

Other extremely powerful nonpolar antioxidants such as eugenol also happen to have toxicity limits that can easily be exceeded with the misuse of essential oils.

While antioxidants supplementation is widely hypothesized to prevent the development of cancer, antioxidants may, paradoxically, interfere with cancer treatments. One explanation for this effect is that the growth-promoting environment of cancer cells leads to high levels of redox stress under baseline conditions, and this makes cancer cells more susceptible than normal cells to the further stress of chemotherapy or radiation therapy. So by reducing the redox stress in cancer cells, antioxidant supplements could decrease the effectiveness of the therapy designed to kill them.[12]

Conclusion:

The imbalance between ROS and antioxidant defense systems may increase the oxidative burden and lead to the damage of macromolecules. Such processes are thought to play a role in pathological processes of various diseases. Antioxidants, which can scavenge the free radical, have an important role in biological system and their use is implicated in the prevention of cancer, heart diseases, ageing, etc.Human mechanism has an inherent mechanism to reduce the free radical induced injury by enzymatic or non-enzymatic methods. When the normal level of antioxidants defense mechanism is not sufficient for the eradication of free radical induced injury, administration of antioxidants have a potential role to play. Though vitamins play a crucial role in minimizing the free radicals, the main function of vitamin is different. Since herbs are known to exert antioxidant activity and are considered to have less or no toxic effects, they would be the best alternative method when the normal level of antioxidant defense mechanism fails.

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