

Antioxidants: Sources and Importance

Dr. Neelam Poonar, Dr. Bharti Chuohan*

Department of Botany, University of Rajasthan, Jaipur

*Department of Zoology, University of Rajasthan, Jaipur.

Neelampoonar[at]gmail.com

Abstract: Antioxidants protect the body from damage caused by harmful molecules called free radicals. Many experts believe this damage is a factor in the development of blood vessel disease (atherosclerosis), cancer, and other conditions. Antioxidants include some vitamins (such as vitamins C and E), some minerals (such as selenium), and flavonoids, which are found in plants. The best sources of antioxidants are fruits and vegetables. You can find flavonoids in fruits, red wine, and teas. You can also buy antioxidant supplements. It is best to obtain antioxidants from a healthy diet. The human body naturally produces free radicals and the antioxidants to counteract their damaging effects. However, in most cases, free radicals far outnumber the naturally occurring antioxidants. In order to maintain the balance, a continual supply of external sources of antioxidants is necessary in order to obtain the maximum benefits of antioxidants. Antioxidants benefit the body by neutralizing and removing the free radicals from the bloodstream.

Keywords: Antioxidants, free radicals, flavonoids, vitamins

1. Introduction

Free radicals, that are produced in the body due to some metabolic stress releases particularly reactive oxygen species (ROS) that have a greater impact on humans both from within the body and the environment. During metabolism, ROS produced are superoxide (O_2^-), hydroxyl (OH) and hydrogen peroxide (H_2O_2) etc. Moreover, environmental factors such as pollution, radiation, cigarette smoke and herbicides can also generate free radicals. These ROS can damage essential proteins, DNA and lipids and cause various human diseases as a result of 'oxidative stress. Although, the body possess defence mechanisms in the form of enzymes and antioxidant nutrients, which arrest the free radicals. Therefore, antioxidants with free radical scavenging activities may be relevant in the prevention and therapeutics of diseases where free radicals are implicated. WHO has recommended the use of natural antioxidants that can delay or inhibit the lipids or other molecules oxidation by inhibiting the initiation or propagation of oxidative chain reaction.

Antioxidants are substances that when present at low concentrations, compared to those of the oxidisable substrate significantly delays or inhibits the oxidation of the substrate. An important role of antioxidants is to suppress free radical-mediated oxidation by inhibiting the formation of free radicals by scavenging radicals.

The body possess defence mechanisms against free radical-induced oxidative stress, which involve preventative mechanisms, repair mechanisms, physical defense and antioxidant defense. Enzymatic antioxidant defense include superoxide dismutase (SOD), glutathione peroxidase (GPx), catalase (CAT) etc. Non-enzymatic antioxidants are ascorbic acid (vitamin C), α -tocopherol (vitamin E), glutathione (GSH), carotenoids, flavonoids, etc. All these act by one or more of the mechanisms like reducing activity, free radical-scavenging, potential complexing of pro-oxidant metals and quenching of singlet oxygen. It is possible to reduce the risks of chronic diseases and prevent disease progression by either enhancing the body's natural antioxidant defense or by

supplementing with proven dietary antioxidants. The intake of natural antioxidants can be increased by taking fresh and healthy food. Antioxidants are found in varying amounts in foods such as vegetables, fruits, and a variety of other foods. Natural antioxidants mainly come from plants in the form of phenolic compounds (flavonoids, phenolicacids and alcohols, stilbenes, to copherols, tocotrienols) ascorbic acid and carotenoids. The quest for natural antioxidants for dietary, cosmetic and pharmaceutical uses has become a major industrial and scientific research challenge over the last two decades.

2. Classification of Antioxidants

On the basis of origin antioxidants are classified mainly into;

- (1) Primary or Natural antioxidants.
- (2) Secondary or Synthetic antioxidants.

Primary or Natural antioxidants: antioxidants of this group are phenolic in structure which react with lipid radicals and convert them into more stable products. (Hurrell, 2003). Primary antioxidant includes antioxidant minerals like selenium, copper, iron, zinc and manganese and antioxidant vitamins like vit A, B and E.

Phytochemicals are another group of primary antioxidants which includes phenolic compounds that are neither vitamins nor minerals. These include: Flavonoids: These phenolic compounds give vegetables fruits, grains, seeds leaves, flowers and bark their colours. Catechins are the most active antioxidants in green and black tea and sesamol. Carotenoids are fat soluble colour in fruits and vegetables. Beta carotene, which is rich in carrot and converted to vitamin A when the body lacks enough of the vitamin. Lycopene, high in tomatoes and zeaxanthin is high in spinach and other dark greens herbs and spices-source include Diterpene, rosmariquinone, thyme,

Secondary or synthetic antioxidants: These are phenolic compounds that perform the function of capturing free radicals and stopping the chain reactions, the compound include

- i. Butylated hydroxyl anisole (BHA).
- ii. Butylated hydroxytoluene (BHT).
- iii. Propyl gallate (PG) and metal chelating agent (EDTA).
- iv. Tertiary butyl hydroquinone (TBHQ).
- v. Nordihydro guaretic acid (NDGA). (Hurrell, 2003)

Antioxidants can be also categorized on the basis of their solubility: **Lipid-soluble antioxidants and water-soluble antioxidants**. Lipid-soluble antioxidants are the ones that protect your cell membranes from lipid peroxidation. They are mostly located in your cell membranes. Some examples of lipid-soluble antioxidants are vitamins A and E, carotenoids, and lipoic acid.

Water-soluble antioxidants are found in aqueous fluids, like blood and the fluids within and around cells (cytosol or cytoplasmic matrix). Some examples of water-soluble antioxidants are vitamin C, polyphenols, and glutathione.

Antioxidants can also be categorized as enzymatic and non-enzymatic antioxidants. **Enzymatic antioxidants** remove dangerous oxidative products by converting them into hydrogen peroxide, then into water by enzymatic degradation. Enzymatic antioxidants cannot be found in supplements, they are produced in your body. The main enzymatic antioxidants in your body are: **Superoxide dismutase (SOD), Catalase (CAT), Glutathione peroxidase and glutathione reductase**.

Non-enzymatic antioxidants benefit you by *interrupting free radical chain reactions*. Some examples are carotenoids, vitamin C, vitamin E, plant polyphenols, and glutathione (GSH). Most antioxidants found in supplements and foods are non-enzymatic, and they provide support to enzymatic antioxidants by doing a "first sweep" and disarming the free radicals. This helps prevent enzymatic antioxidants from being depleted.

3.Sources of Antioxidants

Antioxidants and free radicals are present inside of our body, some antioxidants are made from the body itself, while others we consume from our diet by eating high antioxidant foods that are known as **anti-inflammatory foods**.

Antioxidants include dozens of food-based substances such as **carotenoids** like beta-carotene, **lycopene** and vitamin C. These are several examples of antioxidants that inhibit oxidation, or reactions promoted by oxygen, peroxides and/or free radicals. The overall health benefits which we gain from intake of antioxidants includes slower signs of aging, reduced cancer risk, detoxification, longer life span, protection against heart disease and stroke, less risk for cognitive problems such as dementia, reduced risk for vision loss or disorders like macular degeneration and **cataracts**.

a) Glutathione: **Glutathione** is considered the body's most important antioxidant because it's found *within* the cells and helps boost activities of other antioxidants or vitamins. Glutathione is a peptide consisting of three key

amino acids that plays several vital roles in the body, including helping with protein use, creation of enzymes, detoxification, digestion of fats and destruction of cancer cells.

b) Quercetin: Derived naturally from foods like berries and leafy greens. Most studies have found little to no side effects in people eating nutrient-dense diets high in quercetin or taking supplements by mouth short term.

Amounts up to 500 milligrams taken twice daily for 12 weeks appear to be very safe for helping manage a number of inflammatory health problems, including heart disease and blood vessel problems, allergies, infections, chronic fatigue, and symptoms related to autoimmune disorders like arthritis.

c) Lutein: **Lutein** has benefits for the eyes, skin, arteries, heart and immune system, although food sources seem to be generally more effective and safer than supplements. Some evidence shows that people who obtain more lutein from their diets experience lower rates of breast, colon, cervical and lung cancers.

d) Vitamin C: Known for improving immunity, vitamin C helps protect against colds, the flu, and potentially cancer, skin and eye problems.

e) Resveratrol: **Resveratrol** is an active ingredient found in cocoa, red grapes, and dark berries, such as blueberries, mulberries and bilberries. It's a polyphenolic **bioflavonoid** antioxidant that's produced by these plants as a response to stress, injury and fungal infection, helping protect the heart, arteries and more.

f) Astaxanthin: **Astaxanthin** is found in wild-caught salmon and krill and has benefits like reducing age spots, boosting energy levels, supporting joint health and preventing symptoms of ADHD.

g) Selenium: **Selenium** is a trace mineral found naturally in the soil that also appears in certain foods, and there are even small amounts in water. It supports the adrenal and thyroid glands and helps protect cognition. It may also fight off viruses, defend against heart disease and slow down symptoms correlated with other serious conditions like asthma.

h) Lavender Essential Oil: **Lavender oil** reduces inflammation and helps the body in many ways, such as producing important antioxidant enzymes – especially glutathione, catalase and superoxide dismutase.

i) Chlorophyll: **Chlorophyll** is very helpful for detoxification and linked to natural cancer prevention, blocking carcinogenic effects within the body, and protecting DNA from damage caused by toxins or stress. It's found in things like spirulina, leafy green veggies, certain powdered green juices and blue-green algae.

4. Health Benefits of Antioxidant Foods

a) Slow the Effects of Aging by Reducing Free Radical Damage:

As described above, the single most important benefit of antioxidants is counteracting free radicals found inside every human body, which are very destructive to things like tissue and cells. Free radicals are responsible for contributing to many health issues and have connections to such diseases as cancer and premature aging of the skin or eyes.

b) Protect Vision and the Eyes:

The antioxidants vitamin C, vitamin E and beta-carotene have all been shown to have positive effects on preventing macular degeneration, or age-related vision loss/blindness. Many foods that provide these nutrients also supply antioxidants called lutein and zeaxanthin, nicknamed the eye vitamins, and found in brightly colored foods like fruits and vegetables — especially leafy greens and types that are deep orange or yellow. There are more than 600 different types of carotenoids found in nature, but only about 20 make their way into the eyes. Based on concentrations of things like lutein and other carotenoids, examples of antioxidant foods that protect vision include spinach, kale, berries, broccoli and even egg yolks. Research shows that high-lutein sources like spinach are proven to help decrease eye related degeneration and improve visual acuity. Similarly, flavonoid antioxidants found in berries, such as bilberries or grapes (also a great source of the antioxidant resveratrol), may be especially beneficial at supporting vision into older age.

c) Reduce the Effects of Aging on the Skin:

Perhaps most noticeably, free radicals speed up the aging process when it comes to the appearance and health of skin. Antioxidants may help combat this damage, especially from eating sources high in vitamin C, beta-carotene and other antioxidants. Vitamin A and C have been connected to a decrease in the appearance of wrinkles and skin dryness. Vitamin C, specifically, is a powerful antioxidant that can help reduce the effect of oxidative damage caused by pollution, stress or poor diet. **Vitamin A** deficiency has also been linked to skin dryness, scaling and follicular thickening of the skin.

d) Help Prevent Stroke and Heart Disease:

Since antioxidants help prevent damage of tissues and cells caused by free radicals, they're needed to protect against **heart disease** and stroke. At this point, the data does not show that all antioxidants are effective in protecting against heart disease, but some, such as vitamin C, do seem to be.

The *American Journal of Clinical Nutrition* featured a study that found those with **high levels of vitamin C** in their blood had almost a 50 percent decreased risk of stroke. Countless studies also have found that people who consume highly plant-based diets — loaded with things like fresh veggies, herbs, spices and fruit — have a better chance of living longer and healthier lives with less heart disease.

The Department of Preventive Medicine & Public Health at University of Navarra states, "Fruits and vegetables are dietary sources of natural antioxidants and it is generally accepted that antioxidants in these foods are key in explaining the inverse association between fruits and vegetables intake and the risk of developing a cardiovascular event or having elevated levels of cardiovascular risk factors." However, when it comes to heart health, certain studies have found that using vitamin E or beta-carotene supplements should be "actively discouraged" because of the increase in the risk of heart-related mortality.

e) May Help Decrease Risk of Cancer:

Studies have found that high intakes of vitamin A, vitamin C and other antioxidants could help prevent or **treat several forms of cancer**. **Antioxidants have the capability** to control malignant cells in the body and cause cell cycle arrest and apoptosis (destruction) of cancer cells. Retinoic acid, derived from vitamin A, is one chemical that plays important roles in cell development and differentiation as well as cancer treatment.

Lung, prostate, breast, ovarian, bladder, oral and skin cancers have been demonstrated to be suppressed by retinoic acid. Another study collected numerous references demonstrating the findings of retinoic acid in protection against melanoma, hepatoma, lung cancer, breast cancer and prostate cancer. However, there's evidence indicating that the benefits of chemicals like retinoic acid are safest when obtained from food naturally, rather than supplements.

f) Can Help Prevent Cognitive Decline, Such as Dementia or Alzheimer's Disease

Oxidative stress is believed to play a central role in the pathogenesis of neurodegenerative diseases, but a nutrient-dense diet seems to lower one's risk. The *Journal of the American Medical Association of Neurology* reports that higher intake of foods rich in antioxidants, such as vitamin C and vitamin E, may modestly reduce long-term risk of **dementia** and **Alzheimer's**.

5. Conclusion

Research findings revealed that antioxidants inhibit oxidation in the body, also called free radical damage, which is tied to stress. Many studies have found that people eating plant-based diets high in antioxidants, such as the **Mediterranean diet**, have better protection over cognition. We get most antioxidants from our diets, which help counteract effects of an unhealthy lifestyle, such as accelerated aging, damaged or mutated cells, broken-down tissue within the skin or eyes, the activation of harmful genes within DNA, and low immunity. Some noteworthy high antioxidant foods, herbs and supplements include leafy green veggies, artichokes, cocoa, wild berries, green tea, cinnamon, clove, sea vegetables like kelp, spirulina, quercetin or lutein supplements, and essential oils like lavender and frankincense.

References

- [1] Baublis A, Lu C, Clydesdale F, Decker E, (2000). "Potential of wheat based breakfast cereals as a source of dietary antioxidants", <http://www.jacn.org>
- [2] Bjelakovic G, Nikolova D, Gluud LL, Simonetti, R.G; Gluud, C. 2007. Mortality in randomized trials of antioxidant supplements for primary and secondary prevention: systematic review and meta-analysis. *JAMA* 297(8): 842–857.
- [3] Blot WJ, Li JY, Taylor PR, Chu YH, Hsu HF (1993). Nutrition intervention trials in Linxian, China: supplementation with specific vitamin/mineral combinations, cancer incidence, and disease-specific mortality in the general population. The Alpha-Tocopherol, Beta Carotene Cancer Prevention Study Group. The effects of vitamin E and beta carotene on the incidence of lung cancer.
- [4] Borek C (1991). Antioxidants and cancer, science and medicine. *The baby-boomer's guide* New Canaan connecticut keats publishing, 4:51-61.
- [5] Gutter RG (1991). Antioxidants and ageing. *Am. J. Clin. Nutr.*
- [6] Hail N, Cortes M, Drake EN, Spallholz JE (2008). Cancer prevention: a radical perspective. *Free Radic. Biol. Med.*, 45(2): 97-110.
- [7] Hurrell R (2003). Influence of vegetable protein sources on trace element and mineral bioavailability. *J. Nutr.*, 133(9): 2973S–2977S.
- [8] Stanner, S. A., Hughes, J., Kelly, C. N., & Buttriss, J. A. (2004). Review of the epidemiological evidence for the 'antioxidant hypothesis'. *Public Health Nutrition*, 7, 407–422.
- [9] Wilson J, Gelb A (2002). Free radicals, antioxidants, and neurologic injury: possible relationship to cerebral protection by anesthetics. *J. Neurosurgical Anesthesiol.*, 14(1): 66-79.
- [10] *Antioxidants: Its medicinal and pharmacological applications.* Available from: https://www.researchgate.net/publication/228635229_Antioxidants_Its_medicinal_and_pharmacological_applications