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Review Article

Antioxidants and Optimal Health

Jilu Jessy Abraham[1]*, Anil Melath[2], Subair K[1], Afna fathima[3] and Adla Nadeer[3]

[1]Reader, Department of Periodontics, Mahe institute of Dental Sciences, Chalakkara, Mahe

[2]Principal and HOD Department of Periodontics, Mahe institute of Dental Sciences, Chalakkara, Mahe

[3]Final Year Student, Mahe institute of Dental Sciences, Chalakkara, Mahe

***Corresponding Author:** Jilu Jessy Abraham, Reader, Department of Periodontics, Mahe institute of Dental Sciences, Chalakkara, Mahe.

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Abstract

The presence of free radicals in biological materials was first time discovered about 70 years ago. Since then numerous studies have been done and the benefits of free radicals was introduced. Today we know that antioxidant are by products of the enzymatic reactions taking place in an organism. Antigen are biological macromolecules with immune regulation. Anti-aging, anti-radiation, anti-fatigue, anti-inflammation effects [6].

Overproduction of free radicals causes, oxidative stress, aging processes and various diseases like cancer, rheumatoid arthritis, neurodegenerative disease like Alzheimer and Parkinson, atherosclerosis, pulmonary diseases and DNA damage [12].

Hence, compounds with antioxidants are very important these days because they keep in balance between the production of free radical and the speed of their neutralization the body.

Keywords: Oxygen; Antioxidants; Physiological

Introduction

Antioxidants are substances that prevents oxidation of other compounds. Antioxidants has become a necessity in food products to prevent food degradation. Widely used synthetic anti-oxidants are BHA, BHT, TBHQ. Now there is a increased demand for natural compounds showing anti -oxidant activity. This include plants, eg:- fruits, vegetables, spices etc. Aloe vera contains anti-oxidant which is used in the cosmetic, pharmaceutical, food industry. It has increased shelf life and nutritional value of food [4].

Antioxidants have many medicinal purposes. eg: flavonoids which helps to reduce the risk of mortality from coronary heart diseases and myocardial infarction. Also long term consumption of plant polyphenols can protect as from a range of diseases such as cancers, cardiovascular diseases, osteoporosis and diabetes [6].

General health and degenerative diseases of aging can be improved by consuming recommended amount of fruits and vegetables containing anti-oxidants. The powerful action of anti-oxidants in preventing premature lipid oxidation in food suggests that the same compound when consumed with the daily diet, could unfold anti -oxidative and anti- aging effects in human body. Therefore it has been hypothesized that anti-oxidants are helpful in preventing various diseases [9].

Antioxidants are also widely being used in general clinical practices. This is due to the increased role of free radicle oxidative damage of human diseases which shows potential in dental practices [10].

History

In the late 19th and early 20th century, extensive study was devoted to the uses of antioxidants in important industrial processes such as the prevention of metal corrosion the vulcanization of rubber, and the polymerization of fuels in the fouling of combustion engines.

The use of antioxidants was an ancient practice for food preservation, meats and fish were permeated with phenolic compounds. Subsequently some researcher's observed that addition of small amounts certain compounds could delay deterioration of other substances in the air.

- Lumiere and seyewetz brothers discovered antioxidant role of hydroquinone and analogous compounds
- Moureu and Dufraisse, summarized their work in a memoir titled "catalyse et prooxygene "(1926).

Classification

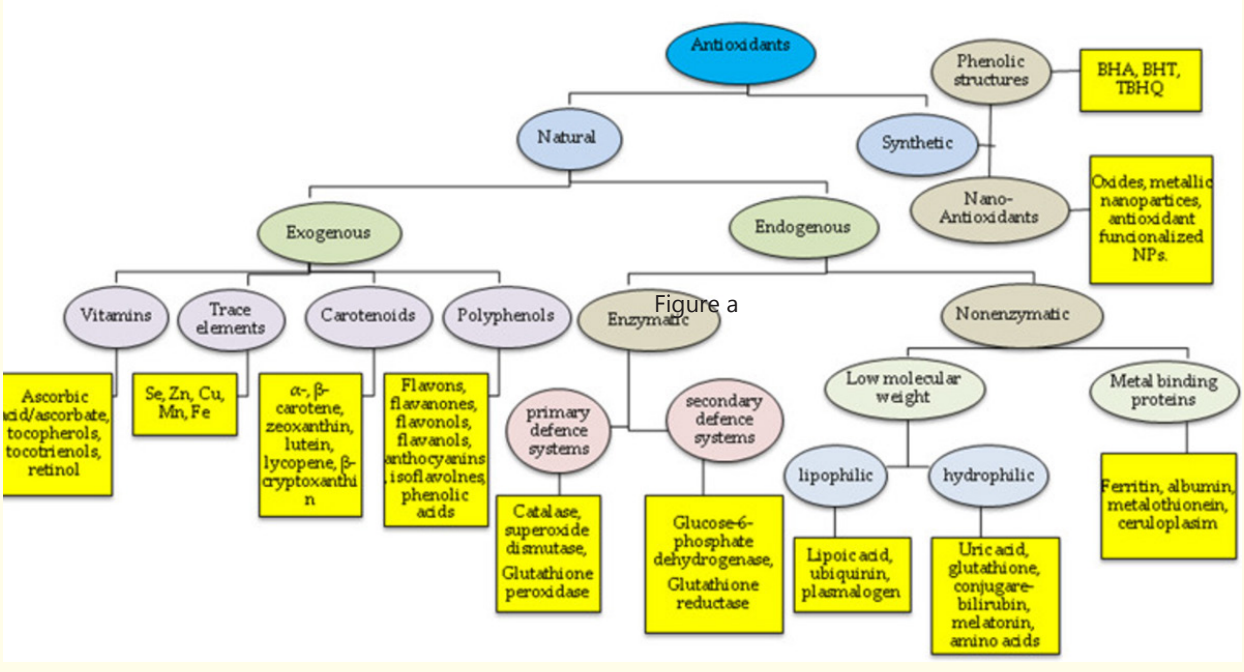

Figure a

Figure a

Type of antioxidants	Examples	Functions
Free radical scavengers	Synthetic antioxidants: BHA (butylated hydroxyanisole) BHT (butylated hydroxytoluene) TBHQ (tert-Butylhydroquinone) Propyl gallate Natural antioxidants: Tocopherols Aromatic amines Phenolic antioxidants (extracts from aloe,spices and herbs	Blocking of the radicals by donating A hydrogen atom
Oxygen scavengers and reducing agents	Ascorbic acid Erythorbic acid	React with oxygen

Table a

Natural sources of antioxidants

In recent physiological studies it shows that it is more advisable to maintain the delicate redox balance than to interfere with the antioxidant homeostasis by a non-physiological, excessive exogenous supply of antioxidants in healthy humans [4].

Synthetic antioxidants may cause adverse effects in humans, hence natural sources of antioxidants were sought after. Various studies have shown the effectiveness of certain plant materials in the reduction of oxidation reaction. Such plants have been used by the humans for a long period of time due to their positive effects, they include tea, coffee, aloe, herbs and spices. These materials have high active compound content which makes them a suitable source of effective and safe natural food additives [4].

Based on mechanism of action antioxidants are classified into primary and secondary antioxidants. primary antioxidants include natural and synthetic materials. In which primary natural antioxidants include tocopherols, flavonoids and esters of gallic acid. The secondary antioxidants include peroxide decomposers such as thioethers, methionine, metal chelaters and glutathione peroxidase [4].

Proteins also inhibit lipid oxidation in food i.e., proteins originating from milk, blood plasma and soy protein. Procine in blood plasma contains antioxidant proteins such as albumin and transferrin. Peptides also inhibits lipid oxidation in foods eg :- cansein, soy and egg yolk has shown to inhibit antioxidants in various muscle foods . Carnosine and anserine are histidine containing dipeptides found in skeletal muscle and they exhibit antioxidants properties [4].

Mechanism of action

Antioxidants are substances that when present even at low concentration will significantly delay or inhibit oxidation of the oxidative substrate. Free radicals that are harmful to the body are produced during metabolism and sometimes the immune system cells create them to neutralize harmful pathogens. Antioxidants neutralize free radicals by donating one of their electrons, ending the electron stealing reaction. Environmental factors like pollution, radiation and smoking also produce free radicals. The antioxidants does not become a free radicals by donating electrons because they are stable in both forms [13]. There are three types of important antioxidants they are the chain breaking or scavenging ones (eg: vitamin E, C and A), those containing thiol groups (the preventive antioxidants: albumin, transfer in, lactoferrin) and the enzyme antioxidants (eg: catalase and glutathione peroxidase). The delicate balance between beneficial and harmful effects of free radicals is a very important aspect of living organisms and it is achieved "redox regulation". The process of redox regulation protects living organisms from various oxidative stresses and maintain "redox homeostasis" [12].

Reactive oxygen species (ROS) are produced by various endogenous (cytokines, growth factors and metabolic processes) and exogenous substances (cigarette smoke). ROS has an unpaired electron which makes the highly reactive and dangerous to cell life thus antioxidants provide an extra electron needed to stabilize or breakdown ROS [7].

Characteristics of antioxidants

An efficient antioxidant should be able to detect and prevent a chain of oxidative propagation. It does so by stabilizing the free radical generation by oxidation, thereby reducing the oxidative damage to the body. There are two main types of anti-oxidants Primary and secondary or Preventive. Secondary anti-oxidant methods may include iron blockade, inhibition of lipid hydroperoxides by disrupting the production of unwanted volatiles reactivation of key anti-oxidants and termination of single oxygen. Therefore anti -oxidants can be defined as those substances, small amounts that works to prevent or significantly delay oxidation of oxidizable substances such as fats [9].

Role of antioxidants in normal physiological functions and diseases

Oxygen free radicals or ROS are well recognized for playing a dual role as both harmful and beneficial to the living system. Beneficial effects of ROS occur at low or moderate concentration. For example, they act as a defense against infectious agents, in a number of cellular signaling system, it also has a role in cellular response to noxia. The harmful effects of ROS is due to over production of ROS on one side and deficiency of enzymatic and non-enzymatic antioxidants on the other side. The harmful effects of ROS causes biological damage. It is termed as oxidative stress. The excessive production of ROS causes damage to cellular lipids, proteins and DNA inhibiting their normal function. Therefore, balance of oxidative stress is a very important aspect of living organism and is achieved by mechanism called "reduction regulation" [12].

A great number of physiological functions or maintained by the redox signalling pathway such as

- Redox regulated production of NO
- ROS production by phagocytic NAD(P)H oxidase

- ROS production by NAD(P)H oxidase in non-phagocytic cells
- Regulation of vascular tone and other regulatory functions of NO
- ROS production as a send Sir for change of oxygen concentration
- Redox regulation of Cell adhesion different artificial train with artificial

Oxidative stress have been the cause of various diseases such as cardiovascular disease, cancer, neurological disorder, diabetes, ischemia or reperfusion, other diseases and aging [12].

Medicinal prospect of antioxidants

Antioxidants are involved in protection of the biological system by

- Inhibiting the creation of new radicals (superoxide dismutase, catlase, Se, Cu, Zn)
- Catching the free radicals to evade chain reaction (vitamin C and E, carotenoids)
- Restoring the impairment affected by free radicals (lipases, proteases).

Intake of antioxidants helps to prevent free radical formation, which in turn prevents acute or chronic diseases, such as Alzheimers, cancer, aging, liver, cardiovascular diseases [6].

Synthetic or natural antioxidants at optimum concentration act as a tool for early prevention of this condition. Antioxidants, avert or remove oxidative stress related diseases by counter acting the deteriorating effect of ROS. Antioxidants also nullify the action of free radicals and provide the finest cellular function. Antioxidants such as vitamin C is a water-soluble antioxidant which act as protection for lipids from peroxidation. Synthetic antioxidants are used to preserve Bloom, nutritional importance, flavor and color of food products. The harmful effects of ROS are controlled by the antioxidant action of the non-enzymatic antioxidant in addition to antioxidant enzymes such antioxidant defenses are very important for direct removal of free radicals and protection of biological site. The present lifestyle of majority of people leads to large amount of free radical in human body which damages cells, tissues and organs which shortens the life span. Intake of antioxidant helps to reduce excess formation of free radical which in turn reduces acute and chronic diseases [6].

Antioxidants in clinical dentistry

Antioxidants are now commonly used in general clinical practice. Growing interest in the role of free radicals and oxidative damage in human disease, coupled with increased research, suggests their potential application in dentistry as well. In developed countries, the consumption of antioxidant supplements has become widespread, with approximately one-third of adults regularly using them [9].

Rationale of antioxidants usage in dentistry

Free radicals seem to influence many oral diseases, most commonly periodontitis. Though oxidative stress is implicated in the pathogenesis of periodontitis, it is seen that the total antioxidant capacity of gingival crevicular fluid (GCF) volume and2plasma appears compromised. The periodontal tissues also provide an ideal medium to study the mechanisms of reactive oxygen species (ROS) mediated 3 tissue damage and of antioxidant defense in response to bacterial colonisation. Ascorbic acid deficiency has been shown to be a conditioning factor in the development of gingivitis [6].

Recommendations in dental practice

Antioxidant therapy may be a double edged sword with negative and undesirable effects, if the safety threshold of the therapeutic dose is surpassed. If administration of antioxidant supplements decreases free radicals, it may interfere with essential defensive mechanisms for eradicating the organism of damaged cells, including those that are precancerous and cancerous. Hence there is a need for a specific endpoint while evaluating the efficacy of antioxidants. Clinical studies to identify biomarkers for antioxidant status and oxidative stress, cytokine multiplexing and gene arrays need to be done. The ratio of overall benefit: risk assessment needs to be evaluated when prescribing these in clinical dentistry. The following points should be considered strongly by the dental practitioners before considering antioxidant therapy:

- Has oxidative damage been implicated in the disease pathophysiology?

(The disease should ideally have been associated with increased lipid peroxidation or oxidation of protein or DNA).

Is the oxidative activity a central pathophysiological feature of the disease?

- Oxidative damage can sometimes be an epiphenomenon, meaning it occurs secondary to the primary cause of tissue disruption and cell death. However, even if oxidative damage is not the root cause of a disease, it can still contribute to additional harm and complications. Therefore, addressing oxidative damage may help reduce preventable morbidity, improving patient outcomes by mitigating further tissue damage and associated complications.

Where is the oxidative damage occurring?

- Absolutely, oxidative damage can occur in various cellular and extracellular environments. Intracellularly, it can affect organelles such as mitochondria, leading to dysfunction. Extracellularly, it can impact proteins and lipids in the extracellular matrix or in lipoproteins circulating in the bloodstream. Lipid-soluble environments, such as membranes, are particularly susceptible due to the presence of unsaturated fatty acids that are prone to oxidation.

Will the antioxidants get to that area?

Yes, that's correct. Antioxidants are beneficial in individuals who have high baseline levels of reactive oxygen species (ROS), which can cause oxidative stress. By neutralizing ROS, antioxidants can help reduce oxidative damage and its associated complications. However, in individuals with lower innate levels of ROS, excessive antioxidant supplementation can potentially disrupt normal cellular signaling and redox balance, leading to harmful effects. Therefore, the use of antioxidants should be tailored to the specific needs and conditions of the individual [6].

Currently, there are few studies available to extrapolate the therapeutic effects of antioxidants in dental practice. While there have been promising results overall, the benefit-to-risk ratio should be carefully considered [6].

Ongoing research illustrates positive findings for antioxidants in clinical dentistry. However, numerous issues need to be addressed due to lack of firm evidence. A substantial gap still exists in our knowledge of bioavailability, biotransformation and mechanism of action of antioxidants. Large scale RCTs and unbiased studies addressing the safety and standardization issue of antioxidants in dentistry are also required [6].

Recent discovery of natural antioxidants

Acacia sinuata

- This belongs to the family Mimosaceae. Higher contents of flavonoids and phenolic compounds can be seen in the leaves than in any other part of Acacia Sinuata.
- The activity of antioxidants in the phonelic and flavonoids can be measured using DPPH and ferric reducing power assays [14].

Achillea Millefollium

- This belongs to the family Asteraceac, commonly known as yarrow.
- Traditionallly the flowers and leaves of this plant is used to treat gastrointestinal diseases.
- Fever, hemorrhoids, dyspepsia and gastritis is treated with the infusion of dried flowers [14].

Ageratum houstonianum

- This belongs to the family Asteraceae.
- It is used for the treatment of skin and wound disease, leprosy as well as purulent ophthalmia
- Also used for the treatment of pneumonia when rubbed on the chest of the patient [14].

Allium cepa

- This belongs to the family liliaceae, commonly known as onion
- Various therapeutic effects of A. cepa have been reported against various diseases [14].

Allium vineale

- This belongs to the family liliaceae.
- It is well known for its biological and medicinal activities against various diseases.
- Phenolic compounds have been isolated from water soluble fraction. Its antioxidant activity is evaluated using DPPH free radical scavenging activity assay, ferric ion reducing.
- Antioxidant power assay, the ferric thiocyanate method and ferrous ion metal chelating activity assay [14].

Annona squamosa

- This belongs to the family Annonaceae and is commonly known as custard apple.
- Due to the high flavonoid content the extracts of *A. squamosa* shows the greatest antioxidant activity [14].

Annona coriacea

- This belongs to the family Annonaceae.
- Pharmacologically it is used for treating several disease [14].

Anredera cordifolia

- This belongs to the family Basillaceae
- It is the main source of many bioactive compounds including saponins,flavanoids,steriods,coumarins.
- It's antioxidant activity is measured using DPPH assay [14].

Brown rice

- Increased chemical content in the brown enhances its antioxidant activity after germination [14].

Capsicum anum

- Commonly known as red chilli
- It contains apigenin, catechin and rutin which makes it valuable as a antioxidant [14].

Capsicum anum L

- This belongs to the family solanaceae
- It contains flavonoids, phenols and ascorbic acid
- It's antioxidant activity is measured using DPPH assay and ABTS assays [14].

Coffee

- The therapeutic potential of coffee is proved against various diseases, they are mainly due to the presence of phytochemical constituents.
- Coffee has a strong antioxidant value to prevent against diabetes mellitus [14].

Glycine max

- It is commonly known as black seed soyabean.
- It's high level of nutrients along with other compounds made it to use as a folk medicine.
- Protein hydrosylate has been isolated from the germinated black soyabean and its in vitro antioxidant activity is measured using DPPH assay, which revealed its scavenging activity [14].

Green vegetables

- It has high content of chlorophylls, carotenoids and flavonoids.
- These contents exert it's antioxidant activity of the plants and their extracts.
- Fresh spinach exhibited high level of antioxidant capacity to kale extracts due to the presence polyphenols and flavonoids [14].

Conclusion

The endogenous defence mechanism of our body is damaged by the imbalance between antioxidant defence mechanism and the oxidative stress. Oxidative stress show crucial role in the propagation of many life threatening disease. Researchers are seeking natural sources of antioxidant which substitute the synthetic drugs .The protective effect of antioxidant continues to be studied around the world [4].

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