DOI:10.15636/jdp/2014/v1i2/58405

*REVIEW ARTICLE*

# Role of Antioxidants in Dentistry

*Abdulla Mufeed*, Reshma V.J. **, Punit Bharadwaj***, Priyanka Chand Kaushik*****

A B S T R A C T

*An antioxidant is a molecule which inhibits oxidation reaction. Antioxidants terminate the chain reaction caused by free radicals of oxidation reaction thereby preventing cell damage or death of the cells. Antioxidants are widely available and safety and efficacy of antioxidants are proved by clinical research. However, lack of randomized controlled trials in dental research limits their usage. This article highlights the clinical significance of antioxidant therapy in dental practice.*

***Key words**: Antioxidants, Free radicals, Multi vitamins, Oxidative stress.*

**Introduction**

Antioxidants are molecules that inhibit oxidation of other molecules, thereby preventing formation of free radicals. These free radicals can cause harmful chain reactions that are responsible for cell damage or cell death, which in turn lead to carcinogenesis. Antioxidants neutralize these radicals by donating their electrons there by ending the electron taking reaction[1]. Antioxidants are widely used for a spectrum of clinical situations in routine practice. An increased interest in the role of free radical oxidative damage in human diseases along with an upsurge in research implies its potential in dental practice too.

**Requisite characteristics for effective antioxidants:[2]**

The requisite characteristics for effective antioxidant molecules include a number of structural features:

1. The presence of hydrogen/electron-donating substituents with appropriate reduction potentials, in relation to those of the redox couples of the radicals to be scavenged.

2. Ability to delocalize the resulting radicals, whether a phenoxyl radical such as those derived from α-tocopherol or butylated hydroxytoluene, a aryloxyl radical such as those derived from flavinoids, a poly unsaturated hydrocarbon chain radical such as β-carotene, or a thiol radical such as dihydrolipoic acid.

3. The transition metal chelating potential dependent on the nature of the functional groups and their arrangement within the molecule.

Based on these protective properties, a number of antioxidants have been derived from different sources. The clinically significant are listed below (Table.1) [2,3]

**Table.1**

| **Antioxidant** | **Mode of action** | **Location/ significance** |
|---|---|---|
| **Ascorbic acid (Vitamin C)** | Chain breaking (Scavenging)<br>Preventive (binds metal ions)<br>Regenerates alpha-tocopherol | Plasma, saliva, GCF, CSF, Synovial fluid.<br>Deficiency leads to gingival bleeding |
| **Alpha-tocopherol (Vitamin E)** | Chain breaking (Scavenging) | Plasma, saliva, GCF<br>Prostaglandin inhibitory effect can contribute in reducing periodontal inflammation |
| **Carotenoids (Vitamin A)** | Chain breaking (Scavenging) | Plasma<br>Deficiency leads to periodontal destruction |
| **Bilirubin** | Chain breaking (Scavenging) | Plasma |
| **Caeruloplasmin** | Preventive (binds metal ions) | Plasma, saliva, GCF |
| **Haptoglobin** | Preventive (binds metal ions) | Plasma, GCF |
| **Transferrin** | Preventive (binds metal ions) | Plasma, saliva, GCF |
| **Uric acid** | Chain breaking (Scavenging) | Plasma, saliva, GCF |
| **Curcuminoids** | Inhibits generation of potent free radicals like Superoxide and hydroxyl radicals | Antibacterial, fungicidal, cytotoxic and enhance wound healing. |
| **Green tea extract (Epigallocatechin- 3-gallate)** | Scavenging effect | Reduce the risk of dental caries and plaque formation. Effective in oral leukoplakia. |
| **Spirulina fusiforms (blue green micro algae)** | Potent quencher of highly reactive singlet oxygen | Effective in Squamous cell carcinoma |
| **Reduced glutathione** | Chain breaking (Scavenging) | Plasma, alveolar lining fluid of lungs |

**Salivary Antioxidants**

Saliva is a heterogeneous fluid rich in antioxidant compounds. Since mouth is the first entrance of the body for the food, drink and inhalants, saliva is the first milieu for those environmental materials. It has been shown that, saliva includes many defensive mechanisms such as secretory IgA and protein–enzymatic defence system, histatin, lysosin and lactoferrin. On the contrary, nowadays, another salivary defence mechanism called as salivary antioxidant system (including uric acid, superoxide dismutase, catalase and glutathione perioxidase) is known. Uric acid is the major component of the salivary antioxidant system constituting 70% of the total antioxidant capacity [4].

**Periodontal Diseases**

Periodontal diseases are inflammatory disease process resulting from interaction between bacterial attack and host inflammatory response. Free radicals and reactive oxygen species (ROS) are responsible for the inflammatory response. Periodontal pathogens can induce ROS overproduction and thus causes collagen and periodontal tissue breakdown. When ROS are scavenged by antioxidants, collagen breakdown can be minimised. Although poor nutrition does not cause periodontal disease directly, many researchers believe that disease progression become faster and more severe in people with nutrient-poor diets because of compromised host response.[5]

Decreased levels of vitamins A and C, β carotene, and β crytoxanthin significantly increase the risk of gingival disease. Low levels of most antioxidants are a risk factor for periodontal disease and infection. Free radicals are released as a result of bacterial clearance and killing. Periodontal tissue depends on natural antioxidants to overcome this oxidative stress and maintain homeostasis. When antioxidants are depleted, the ability of gingival tissue to overcome oxidative stress, maintain normal tissue and control the bacterial damage appears to be compromised. Increased production of reactive oxidative species (ROS) necessitates an elevated need for zinc, copper and selenium, nutrients which are involved in antioxidant defenses.[5]

Systemic glutathione (GSH) is decreased with inflammation. The functions of GSH include antioxidant defense and immune regulation. The vitamins pyridoxal phosphate (B6) and riboflavin (B2) are important in maintaining GSH status. Selenium has important oxidation-reduction functions, and selenium-dependent GSH enzymes are involved in changing lipid and phospholipids hydroperoxides to harmless products, neutralizing the inflammatory process at the cellular level. Therefore vitamins B2, B6, copper, zinc and selenium are needed to maintain systemic glutathione and selenium-dependent GSH enzymes for antioxidant defense, immune regulation, and neutralization of the inflammation process at the cellular level[5].

Micronutrients such as beta-carotene and vitamins like A, C and E can be depleted during inflammation. As mitochondria produce energy, they release ROS within the cell. It was suggested

suggested that dietary vitamin C enters the mitochondria and protects against oxidative injury. These vitamins support immune functions and are involved in the maintenance of structural and functional integrity of epithelial tissues and physiological or metabolic parameters relevant to periodontal health [4].

**Dental Caries**

Dental caries is one of the most common oral health problems and its prevention is one of the most important strategies in preventive dentistry. It affects all people regardless of their sex, socioeconomic strata, race, and age. It is also profoundly affected by other factors like oral hygiene and saliva [6]. Recently, it has been claimed that the imbalances in levels of free radicals, reactive oxygen species, and antioxidants in saliva play an important role in the onset and development of dental caries. Hence, evaluation of those factors in saliva that may increase the risk of individuals to dental caries, can pave way to make recommendations that will cater specifically to needs of an individual. Most important would be the function of salivary peroxidase system, which constitutes one of the major salivary antioxidant systems. Salivary peroxidase brings the control on oral bacteria which lead to dental caries. Salivary peroxidase catalyzes the peroxidation of thiocyanate ion (SCN-) to generate oxidation products (more stable OSCN); this inhibits the growth and metabolism of many micro-organisms thereby inhibiting caries or atleast slowing down the progress of caries[7].

**Oral Cancer and Precancers**

Antioxidants show preventive and therapeutic potential in many stages of oral carcinogenesis. Researchers have recently stated there is inhibition of oral cancer phenotypes after antioxidant intakes. The administrations of proanthocyanidins that can be found in flavonoid structures of antioxidants have an ability to reduce cell growth and proliferation of oral carcinomas[1]. Dietary antioxidants can protect the lipids and other membrane molecules against oxidative damage by intercepting oxidants before they try to destroy the tissues.[8]

Reversal or suppression of premalignant lesion is an important strategy against carcinogensis for the prevention of cancer. Studies using animal models, epidemiological surveys and interventional trials have established the chemopreventive role of various antioxidant nutrients such as beta carotene and Vit E against oral cancer [8]. Vitamin such as A, Beta carotene, C, E, B12 and folate are the micro nutrients with the strongest evidence of having a link to cancer prevention and control. Deficiency of these vitamins at the dietary, systemic or mucosal level will interact with tobacco use and increased the risk of oral precancerous lesions [8]. The use of Vit A supplements in the treatment of oral leukoplakia began in the early 1960s. Silverman et al [9] reported administration of 3-9 lakhs IU of Vit A per day resulted in partial or complete resolution of leukoplakia. A population based case-control study from Japan showed that males with leukoplakia had significantly lower levels of serum lycopene and beta carotene than controls [10].

Studies have shown that turmeric has a beneficial role in the treatment of OSMF. Curcuminoids isolated from turmeric has been found to have effective antioxidant, DNA protectant and antimutagen action[11]. In a study reported in 2007 to evaluate the efficacy of oral lycopene in OSMF patients found statistically significant improvement in the mouth opening values[12].

In view of the anti-keratinizing and immunomodulatory effects of retinoids, these agents have been used both topically and systemically to control oral lichen planus. The retinoids have anti-inflammatory properties and are known to reduce CD4 lymphocyte infiltration in lichen planus[13].

**Limitations of antioxidants**

High doses of vitamin A showed to have embryotoxic and teratogenic effects. Large doses of vitamin C (ascorbic acid) may be associated with the inhibition of ovarian steroidogenesis and increased probability of abortion[14]. Antioxidant supplements were once thought to be harmless but increasingly we are becoming aware of their interactions and potential toxicity. Also, very little is known about the long-term consequences of mega doses of antioxidants.

**Conclusion**

There is overwhelming evidence that oxidative stress occurs in cells as a consequence of normal physiological processes and environmental interactions, and that the complex web of antioxidant defence systems play a key role in protecting against oxidative damage. Its effects have been studied extensively in all the human body systems and almost all known diseases. Agreement should be arrived at the optimal dose of supplementation of specific antioxidants with respect to specific situations. Until then, antioxidant supplementation could be promoted by the health fraternity and the dental team as the benefits outweighs the risks in several folds.

**References:**


1. Aksakalli S. Antioxidants in dentistry : Review of literature. Dentistry 2013: 4(1);181.
2. Helmut Sies, Wilhelm Stah, Vitamins E and C, α-carotene, and other carotenoids as antioxidants. Am J Clin Nutr l995;62(suppl):l3;15S- 215.
3. S Carnelio, S A Khan, G Rodrigues. Definite, probable or dubious: Antioxidants trilogy in clinical dentistry. BDJ 2008: 204(1); 29-32.
4. Ian LC Chappel. Role of free radicals and antioxidants in the pathogenesis of the inflammatory periodontal diseases. J Clin Pathol Mol Pathol 1996;49: M247- M255.
5. Local and systemic total antioxidant capacity in periodontitis and health G. R. Brock, C.J. Butterworth, J. B. Matthews and I. L. C. Chapple J Clin Periodontol 2004; 31: 515–521.
6. Battino M, Ferriero MS, Gallardo I, Newman HN, Bullon P. The antioxidant capacity of saliva. J Clin Periodontol 2002; 29:189-194.
7. Bhuveneshwari P. Antioxidants in Oral health care. J Pharm Sci and Res 2014; 6(4): 206-209.

DOI:10.15636/jdp/2014/v1i2/58405

## ABOUT THE AUTHORS:

*Dr Abdulla Mufeed is a Reader in the Department of Oral Medicine and Radilogy, MES Dental College, Perinthalmanna, Kerala, India.

Email address: abmufid@yahoo.co.in

**Dr Reshma VJ is a senior lecturer in the Department of Oral Medicine and Radilogy, MES Dental College, Perinthalmanna, Kerala, India.

*** Dr Punit Bharadwaj is a Reader in the Department of Paediatric dentistry, MES Dental College, Perinthalmanna, Kerala, India.

****Dr Priyanaka Chand Kaushik is a Senior Resident in the Department of Periodontics, GDC Alapuzha, Kerala , India.

8. Shafer WG, Hine MK, Levy BM. A Text Book of Oral Pathology. WB Saunders Company 5th ed. 1993.567-658.
9. Tenovuo J, Lehtonen OP, Aaltonen AS, Vilja P. Antimicrobial factors in whole saliva of human infants. Infect Immun. 1986;51:49-53.
10. Garewal H. Antioxidants in oral cancer prevention. Am J Clin Nutr 199; 62: 141-146.
11. Silverman S jr, Renstrup G, Pindborg JJ. Studies in oral leukoplakias:III. Effects of vit A comparing clinical, histopathologic, cytologic and hematologic responses. Acta Odont Scand 1963; 21: 271-92.
12. Nagao T et al. Serum antioxidant micronutrients and the risk of oral leukoplakia among Japanese. Oral oncology2000;36:466-470.
13. Roth GN, Chandra A, Nair MG. Novel bioactivities of Curcuma longa constituents. J Nat Prod 1998;61;542-545.
14. Kumar a et al. Efficacy of lycopene in the management of oral submucous fibrosis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:207-213.
15. Baudet PM, Janin MA, Souteyrand P. Sequential immunopathologic study of oral lichen planus treated with retinoin and etretinate. Oral Surg Oral Med Oral Pathol 1991;71:197-202
16. Lingam A Swapna, Koppolu Pradeep, Padma Reddy, Koppolu Deepak, Stuti Goyal. Antioxidants and their implications in oral health and general health. IJCRI 2014;5(4):258-263.