

Antioxidants in Oral Health

¹Dr. Henna Mir, ²Dr. Shivalingesh KK, ³Dr. Adeeba Saleem, ⁴Dr. Divya Srivastava, ⁵Dr. Swati Pathak

¹⁻⁵Institute of Dental Sciences, Bareilly

Corresponding Author: Dr. Henna Mir, Institute of Dental Sciences, Bareilly

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Abstract

Topical antioxidants can affect oral cells. As an alternative medicine herbal remedy is a form of treatment for multiple medicinal and dental problems to be remedied. Antioxidants in combination with dried, fresh, and blended herbal paste were also used. Antioxidants block the oxidation cycle by the neutralisation of free radicals. In doing so, the antioxidants are oxidized themselves. While fruits and vegetables have multiple advantages because they help to reduce free radical harm from environmental contaminants (including radiation) in clinical research, in several in vitro and animal tests, supplements of vitamins C and E and beta-carotene typically do not reduce DNA harm from irradiation. There are fair evidence which show that vitamin C has no effect on cancer.

Keyword: stress, oxidants, oral health

Introduction

Oxidative stress has been defined as a mechanism arising from the failure of the endogenous antioxidant defenses of the body to scavenge free radical species and has been correlated with many pathologies such as aging,

cardiovascular disease, neurodegenerative disorders, cancer, complex regional pain syndrome and many others.¹ This oxidation reaction is inhibited by a molecule called as antioxidant. Antioxidants end the chain reaction caused by the free oxidation reaction radicals, stopping cell destruction or cell death. Insufficient amounts of antioxidants or antioxidant enzyme inhibition cause oxidant stress and destruction, or destroy cells. Antioxidants are obtained from various sources, including vitamins, minerals, enzymes and hormones, as well as additives of diet and herbal products. The bar, gel, capsule, drops and tablet are the different forms of antioxidant supplements. Toothpastes, mouth rinses/mouthwashes, lozenges, fluoride gels and dentifrices, oral sprays, breath fresheners and other dental products have recently been incorporated as antioxidants by dental manufacturers for the control of gingival and periodontal diseases. Additionally, topical antioxidants can affect oral cells. As an alternative medicine herbal remedy is a form of treatment for multiple medicinal and dental problems to be remedied. Antioxidants in

combination with dried, fresh, and blended herbal paste were also used.²

Antioxidants Process

Antioxidants block the oxidation cycle by the neutralisation of free radicals. In doing so, the antioxidants are oxidized themselves. Chain-breaking and preventive are also potential mechanisms.³

Chain-breaking: A second radical is formed as a free radical escape, or an electron abstracts. This molecule then turns into a third molecule and does the same thing, helping to produce more unstable materials. If the radical is stabilized by a chain-breaking antioxidant, such as β -carotene and vitamins C and E, or it merely decays into a harmless substance, the process proceeds until termination.

Preventive: Antioxidant inhibits oxidation by reducing the chain initiation rate. These can also resist oxidation by stabilizing radicals such as copper and iron in transition metals.⁴

Functions of antioxidants

- Free radicals reduction.
- This promotes natural cell growth.
- Protects the cells from early and abnormal aging.
- Helps prevent molecular degeneration linked to age.
- It provides support to the body immune system.⁵

Classifications of antioxidants

On the basis of enzymes

Depending upon enzymes, they are broadly divided into two types:

1. Enzymatic antioxidants.
2. Nonenzymatic antioxidants.

Enzymatic antioxidants are further divided into primary and secondary antioxidants again:

- a. Primary antioxidants: Superoxide dismutase, glutathione peroxidase.

- b. Secondary antioxidants: Glutathione reductase, glucose 6 — phosphate dehydrogenase.⁶

Non-enzymatic antioxidants.

- a. Vitamins: Vitamins A, C, E.
- b. Carotenoids: Beta carotene, lycopene, lutein, zeaxanthin.
- c. Low molecular weight antioxidants: Glutathione, uric acid.
- d. Organo sulfur compounds: Allium, allyl sulfide, indoles.
- e. Antioxidants cofactors: Coenzyme O 10.
- f. Polyphenols: Flavonoids, phenolic acid.

On the basis of food products

There are various kinds of antioxidants, which are present in the food and as well as in the human body. Some foods that contain antioxidants are:

Product antioxidants⁷

Product	Antioxidants
Soya beans	Isoflavones, Phenolic Acids
Green tea, black tea	Polyphenols, Catechins
Coffee	Phenolic Esters
Red wine	Phenolic Acid
Rosemary, Sage	Carnosic Acid, Rosmaric Acid
Citrus and other fruits	Bioflavonoids, Chalcones
Onions Quercetin	Kaempferol
Olives	Polyphenols

Antioxidants and dental health

Antioxidants and dental caries: Dental caries is one of the most common oral health problem and its prevention is one of the most important strategies in many countries. It affects all individuals irrespective of gender, socioeconomic strata, race and age. This is also profoundly affected by other causes, such as oral hygiene and saliva.² It has been suggested recently that the imbalances in the levels of free radicals, reactive oxygen species and antioxidants in saliva that play an important

role in the occurrence and production of dental caries. It has been suggested recently that the imbalances in the levels of free radicals, reactive oxygen species and antioxidants in saliva that play an important role in the occurrence and production of dental caries.² Most significant will be the salivary peroxidase system function which constitutes one of the major antioxidant salivary systems. Salivary peroxidase contributes to the regulation of dental plaque-forming oral bacteria, to biological imbalances, which contributes to dental caries. Salivary peroxidase catalyzes the peroxidation of thiocyanate ion (SCN-) to produce oxidation products (more soluble OSCN-); this prevents the development and metabolism of many micro-organisms and therefore prevents caries or at least, delaying caries progression.⁸

Antioxidants and periodontal diseases

From different studies it was hypothesized that because the periodontal condition is deteriorated due to ROS output, the antioxidants are used to preserve the equilibrium and the normal level decreases.⁹ A strong association was found in a study between the rise in sulcus bleeding scores and grapefruit intake, which contributes to an increase in plasma vitamin C levels. Cereals, nuts, vegetables, chocolates, fats, and drinks such as tea, coffee, wine, and fruit juices are the primary antioxidant sources in a diet.¹⁰

Vitamin C: In vitro studies have shown that Vitamin C decreases the cytotoxic and apoptotic effects of *Porphyromonas gingivalis* (*P. gingivalis*) on gingival fibroblasts. Chapple et al. reported a clear inverse association between serum vitamin C levels and periodontitis prevalence. Jacob et al. observed that regular and elevated levels of vitamin C decreased inflammation of the gingiva and bleeding of the sulcus. Rai et al. observed a close association between the risk of periodontal disease and low serum and saliva levels of vitamin C levels.¹⁰

Vitamin E: Research reported contradictory findings on the relationship between vitamin E and periodontal diseases. Cohen et al. indicated that, in addition to SRP, 5 per cent of topical vitamin E gel did not have a beneficial impact on plaque development and periodontal tissue healing. The same researchers have demonstrated in another study that vitamin E has a beneficial effect against bone loss. Another research found that there was no statistically significant difference in serum vitamin E levels between the patients with periodontitis and the healthy population. A negative association between the α -tocopherol serum levels and the severity of periodontitis was found.

Carotenoids: Carotenoids are strong antioxidants. Linden et al. found that in patients with mild to extreme periodontitis, the α -carotene, β -carotene, β -cryptoxanthin and zeaxanthin rates were considerably lower. Systemic supplementation of 8 mg / day of lycopene in patients with gingivitis was reported to decrease the gingival index. It was recorded that supplementation of 4 mg / day of oral lycopene in addition to SRP for 2 weeks resulted in a reduction in the loss of clinical attachment in individuals with chronic periodontitis.

Coenzyme Q10: Oral supplementation of Coenzyme Q10 has been shown to induce an increase in gingiva density and reduction in periodontal inflammation and micro-organism count.¹⁰

Catechin: It is an important antioxidant present in green tea, with beneficial effects on cancer and cardiovascular disorders. Catechins have also shown to impede the development of periodontal infections and prevent the degradation of periodontal tissues.

Green Tea: It was confirmed that green tea inhibits collagenase production in gingival crevicular fluid in patients with aggressive periodontitis. An antioxidant potential of gingival crevicular fluid was eight times

greater than that of the control group as reported by Chopra et al.

Cocoa: Cocoa also includes flavonoids, and in an experimental study performed in rats, a diet high in cocoa has been shown to suppress the oxidative stress and periodontal damage associated with periodontal disease.¹⁰

Coffee: Coffee, which due to its content of caffeine, caffeic acid and chlorogenic acid is a rich source of antioxidants, has a modulating effect on natural and acquired immune response. In an adult male sample it has been shown that coffee intake decreases alveolar bone loss. However, for men with periodontitis, a higher coffee intake may be an additional risk factor for periodontal disease as suggested by Han et al.

Curcumin: Curcumin has antioxidant properties even due to the amount of phenolic compounds. It has antitumor and anti-inflammatory properties. Oral application of curcumin reduced alveolar bone loss in rats as reported by Bakir et al.

Olive oil: Olive oil contains a significant number of polyphenols, high α -tocopherols concentrations and low carotene concentrations and serves as a chain-breaking antioxidant by its oleuropein content.¹⁰

Melatonin: It has been documented that saliva melatonin levels increased following non-surgical periodontal treatment and that there was a negative correlation between salivary melatonin levels and bleeding during probing.

Selenium: In diabetic patients it was reported that serum selenium, glutathione, and catalase levels are negatively associated with the frequency of periodontal inflammation and tissue degradation.¹⁰

Antioxidants and oral cancer

Vitamin A

Retinoids: Application of chemoprevention is ideally the origin of cancer treatment. A number of dietary ingredients and micronutrients with considerable potential for apoptosis induction are emerging, including chemotherapeutic and chemopreventive medications. Green tea components (EGCG and others) and many other phytochemicals such as retinoids and carotenoids are found in these agents (lycopene).¹¹

Carotenoids, lycopene and others: β -carotene is a source to vitamin A widely present in orange or yellowish foods, dark green, such as spinach, sweet potatoes, carrots, mangoes, oranges and papayas. For the scavenging of free radicals in conditions with low oxygen levels, β -carotene is used in particular. Absolute oral leukoplakia (OL) resolution was observed in one-third (15 out of 46) of patients who used 360 mg β -carotene per week for a duration of over 12 months, as recorded in a recent review.¹²

Lycopene: The main sources of Lycopene are onions, apricots, papaya and other yellow fruits.¹³ Lycopene is hypothesised to preserve essential biomolecules in cells, including lipids, lipoproteins, proteins, and DNA, thereby avoiding arcinogenesis and atherogenesis. Lycopene is seldom associated with oxygen-reacting chemical species, making it the most powerful biological antioxidant.¹⁴

Ascorbic Acid (Vitamin C): The major origins of L-ascorbic acid (L-AA), the so-called vitamin C, are citrus fruits like kiwi, bananas, papaya, and mango. It has been indicated that smokers require a daily dose of at least 140 mg / day, since they usually display a reduction in serum leukocyte L-AA concentration. L-AA has antioxidant properties and interacts with the superoxide produced by the cell's natural metabolic processes; superoxide inactivation prevents the production of nitrosamines

during protein digestion and helps prevent DNA and cell protein damage.¹⁵

Tocopherol (Vitamin E): The common sources of this oil are plant oil, margarine, and green leaves. Tocopherol is an important antioxidant that protects cell membranes against lipid peroxidation at high oxygen levels. Tocopherol's key activities include: scavenging of free radicals, maintenance of membrane integrity, immune function, cancer cell growth/differentiation inhibition, cytotoxicity, nitrosamine production and mutagenicity inhibition, DNA and RNA inhibition, protein synthesis in cancer cells.

Zinc and Selenium: Selenium is a trace element. This forms the active site of several enzymes that are antioxidants, including glutathione peroxidase. Manganese and zinc are trace elements that form an essential part of different antioxidant enzymes, similar to selenium.¹³

Antioxidants and leukoplakia

Beta-carotene: Usage of beta-carotene to reduce oral leukoplakia and likely oral cancer has been recommended. Trials using beta-carotene reported considerably greater declines (up to 71 per cent) in the frequency.¹⁶

Lycopene: Lycopene has the unusual characteristic of being bound to oxygen reacting chemical species, rendering it the most powerful biological antioxidant. Lycopene has an anticancer mechanism, as it has the unique trait of being bound to oxygen-responsive chemical species, making it the most active biological antioxidant.¹⁷

Vitamin A: In managing OL, the use of 13-cRA proved successful.¹²³ A randomised trial conducted at MD Anderson Hospital in Houston, where 44 oral leukoplakia patients were treated with 13-cRA for 3 months at 1-2 mg/kg/day; 32 approximately 67 percent of patients reported a more than 50 percent decrease in lesion size, but 79 percent had a number of side effects as reported by Hong et al.¹⁶ Nevertheless, along with their

side effects, the high recurrence rates after short discontinuation times represent the limiting factors. Careful examination of these patients is also important.¹⁸

Vitamin E: The toxicity and effectiveness of β -tocopherol was tested by Benner et al. in 43 OL patients who used 400 IU twice daily for 24 weeks. Follow-up to determine toxicity, therapeutic reaction, and serum AT levels was performed at 6, 12, and 24 weeks after start of therapy. Absolute clinical lesion remission was found in ten patients (23 percent) and partial clinical response was detected in 10 (23 percent).

Fenretinide: Fetinamide is a vitamin A analogue that was synthesised in the late 1960s in the United States. It has shown to be less harmful than many other analogues of vitamin A.

Bleomycin: Six OL patients with 12 to 15 applications were treated with regular application of topical bleomycin to dimethylsulphoxide (DMSO). Repeat biopsies indicated a decline in keratinization and dysplasia between 10 to 84 days of treatment. Full absorption of all topically applied bleomycin yielding a cumulative systemic dose of 15 mg was confirmed by the investigators.¹⁸

Green tea: Applying tea extracts directly to the lesions can further increase the local concentrations of active components.¹⁸

Spirulina: The blue green microalgae Spirulina was found to be a rich natural source of proteins, carotenoids, and other micronutrients, used in everyday diets by natives of Africa and America. Spirulina fusiformis (1 g / day for 12 months) has chemopreventive activity in reversal of OL in pan tobacco chewers in Kerala, India as evaluated by Mathew, et al. (1995).¹⁹

- **Acitretin:** The topical acitretin mucoadhesive tablet is effective in the treatment of OL without systemic side effects.¹⁸

Antioxidants and OSMF

Lycopene: Lycopene exerts its anti-inflammatory function by increasing resistance of the lymphocytes to stress.¹²⁶ Lycopene is believed to provide greater benefit when paired with intralesional steroids than when used alone. Greater progress in the opening of the mouth was noted when intralesional steroids were paired with lycopene owing to the synergistic impact when both medications were used together. A clinical trial suggested that oral consumption of lycopene enhanced mouth opening and soothed the burning pain in OSF patients.²⁰

Curcumin: The anti-inflammatory, cytotoxic and antioxidant activity of curcumin I, II, III from *Curcuma longa* was described by Ramsevak et al.²¹ Curcumin gel with anti-mutagenic activity is suggested in treating OSMF for extended periods of time.²² It decreases cellular fibrogenic activity and suppresses the connective tissue growth factor TGF- β and iNOS. Curcumin improves mouth opening in OSF patients and effectively ameliorates the burning sensation.²³

Honey: Honey has the properties of scavenging the free radicals, lipoxygenase inhibition, inhibits NF- κ B signaling pathway and inhibits IL-1, IL-10 and COX-2 expression. Scientists use honey against oral diseases such as halitosis, oral submucous fibrosis, stomatitis caused by chemotherapy and oral mucositis caused by radiotherapy. Honey alongwith turmeric significantly improves the burning sensation of OSF patients.²³

B-carotene: Beta carotene plays an important role in OSMF pathogenesis, and its level decreases with the progression of the disease. The degree of oxidative damage in OSMF can be determined by measuring the serum beta carotene levels in patients who are affected, and the underlying antioxidant deficiency can be reversed by dietary treatment with beta carotene. This condition

can be successfully managed by it, and for preventing the malignancy.²⁴

Aloe Vera: Sudarshan et al. performed a preliminary analysis to compare the effectiveness of Aloe Vera to antioxidants in oral submucous fibrosis (OSMF) treatment. A total of 20 subjects with OSMF were included in this study. He concluded that the group Aloe Vera showed better reaction to the treatment than the group of antioxidants.²⁵

Antioxidants and aphthous ulcer

Honey: Honey an ideal skin care and oral care agent, in addition to other vitamin and mineral components. Honey speeds up ulcer cure by reducing bleeding and reducing vascular permeability. Honey is likely to adsorb mucous membrane toxins and precipitate protein, meaning that pus and inflammatory exudates have been adsorbed by natural honey, thereby protecting the underlying tissues and promoting normal healing and epithelialisation.²⁶

Aloe Vera: Because of its medicinal property, various dentrifices also contain Aloe Vera gel as an important constituent. Aloe vera gel has shown a strong anti-candidal activity. Anticandidate efficacy of denture cleaning tablet, triphala, aloe vera and cashew leaf on complete dentures of 50 patients was evaluated, and candida count decreased maximum with use of triphala accompanied by aloe vera, cashew leaf and water (control) as reported by Shetty PJ et al.²⁷

Curcumin: In 2012, a randomized placebo-controlled trial was performed using 2 percent curcumin gel in minor RAS therapy, which revealed that it is a well-tolerated antibacterial, anti-tumor beneficial agent with potent analgesic and anti-inflammatory properties. It was found that there was significant difference from day 0-day 7 in both the groups, respectively between the pain score, size, number, and duration of ulcers. As is consistent with other research, the findings of this study

provide promising evidence that curcumin gel can be used as an effective and healthier alternative to steroids in the treatment of minor RAS.²⁸

Vitamin D: 25-hydroxy vitamin D levels in idiopathic minor recurrent aphthous stomatitis patients was compared with age and sex-matched healthy controls, a study conducted by Khabbazi et al.²⁹ Researchers observed that the levels of 25-hydroxy vitamin D in the research population were significantly lower (12.1 ng / dl vs 27.4 ng / dl).³⁰

Antioxidants and dental caries

Cranberry: The cranberry fruit is a special and abundant bioactive source of polyphenol compounds. Polyphenols demonstrated reduced levels of lactic acid production by *S. mutans*, while bakuchiol (similar to the polyphenol resveratrol found in red wine) and macelignan polyphenols (found in nutmeg) displayed anti-biofilm activity by inhibiting growth of *S. mutans*, *S. sanguinis* and *Actinomyces viscosus*, reported in an in vitro study.³¹ Additional in vitro experiments have shown that some polyphenolic components present in cranberries stopped cariogenic bacteria from developing organic acids by cariogenic bacteria, limited the production of *S. mutans* and *S. sobrinus* biofilm formation, and inhibited the attachment and coaggregation of various additional oral *Streptococcus* organisms, like *S. mitis*, *S. criceti* and *S. oralis*.³² Researchers noted in a laboratory study examining orange peel extract as a caries reduction approach that inhibited *S. mutans*' microbial development, indicating the need for more work to evaluate the effects of such polyphenols when integrated into dentifrices and mouthrinses.³³

Role of antioxidants in endodontics

Proanthocyanidin (Grape Seed Extract): Complexes of oligomeric proanthocyanidine which is extract of grape seed (OPCs) are known mainly for their antioxidant

capacity.³⁴ Application of a proanthocyanidin agent (PA) works by enhancing root dentin bond strength when treated with sodium hypochlorite (NaOCl) as studied by Manimaran et al.³⁵ The beneficial effect of grape seed extract (oligomeric proanthocyanidin complexes {OPCs}) on composite resin bond strength to bleached enamel using 5th and 7th generations of dentin bonding agents were demonstrated in a study by Abraham et al. Results revealed that the use of grape seed extract as an antioxidant after bleaching greatly increases the composite resin's bond strength to the bleached enamel. Another research explored the long-term resin-dentin bond strength of the biomodified dentin by proanthocyanidin-rich (PA) agents.³⁴

Lycopene: The neutralizing action and result of the extract of lycopene (tomato extract) and proanthocyanidin (grape seed extract) on reactive oxygen species (ROS) particularly provided by the mixture when used as an intracanal medication, as explained by Mageshwaran et al.³⁶

Alpha-Tocopherol: Tests revealed that the 10% α -tocopherol antioxidant therapy was the only effective agent to counteract the oxidizing effects of the bleaching procedure on enamel. Some studies showed that soon after the 10 min application of 10% and 25% sodium ascorbate along with 25% alpha tocopherol solutions significantly enhanced and improved the shear bond strength of composite resin when applied to enamel.³⁴

Ascorbate: It is understood that AA helps to increase the dentin bonding strength of adhesive resins when used and applied to dentin surfaces as a C&B Metabond experimental conditioner. SA (Sodium ascorbate is an ascorbic acid salt) is known to improve the bonding strength of adhesive resins on sodium hypochlorite (NaOCl) treated dentin surfaces in operative dentistry and endodontic procedures.³⁷ After treatment with different

irrigants, Vongphan N et al researched the effect of microtensile bonding strengths of all together complete total etching adhesive systems to pulp chamber dentine. They concluded that SA substantially helped strengthen the bond capabilities of root dentine treated with NaOCl. The suitable application and duration of antioxidant sodium ascorbate (SA) gel results in reducing microleakage of bonded composite restoration for intracoronally bleached teeth as determined by Park et al. Application of SA gel also revealed that for three days after nonvital bleaching, microleakage of composite restoration for intracoronally bleached teeth was significantly effective.

Curcumin: Intracanal medicament: *E. faecalis* has been reported to be the predominant microbe seen in the root canal of infected teeth.³⁸ Curcumin serves as an intracanal medicament in endodontic therapy through its anti-microbial action. Neelakantan P et al performed an invitro analysis using Turmeric extract (5 per cent turmeric powder in 10 ml water) on 30 extracted teeth and concluded that Curcumin had antibacterial action against *E. faecalis*.³⁹ Likewise, in 2013, Prabhakar A et al conducted an invitro study in 40 extracted tooth and reported *E. faecalis* inhibition at 54 per cent use of turmeric extract (200gms in 500ml water) and concluded it as an important intracanal medicine.³⁸

Aloe Vera: Aloe Vera's potential (10 percent, 30 percent, and 50 percent concentration) to preserve the viability of human periodontal ligament cells when used for 1, 3, 6, 12, and 9 hours as a storage medium for avulsed teeth was tested and compared to cell culture media. The findings showed that aloe vera's ability to preserve the viability of human parodontal cells is close to that of cell culture media.⁴⁰

Role of antioxidants in restorative dentistry

Vital dental bleaching agents include H₂O₂ or carbamide peroxide, from 3% to 40%. A research comparing the efficacy of 10% sodium ascorbate and 5% proanthocyanidin agents on the bond strength after bleaching found the use of antioxidants before bonding to bleached surfaces reverses the detrimental effect of bleaching agents and improves bond strength.⁴¹

Lai et al. also observed that impaired composite resin bond strength can be restored with the use of antioxidants such as SA after bleaching.

Green tea and white tea are well-proven antioxidants and are becoming increasingly popular because of their herbal and natural properties. There is insufficient data and information about their efficacy as antioxidants after bleaching.

Nearly 10 % ascorbic acid was involved in restoring the affected bonding to oxidized enamel and dentin. Since ascorbic acid is a weak acid, using SA instead of ascorbic acid is advised to prevent unwanted double etching results.

5% green tea extract has been shown by various studies to be an alternative substance to restore the reduced shear bond strength in bleached enamel using an in-office technique.⁴²

Manimaran, et al. researched the application of proanthocyanidin agent (PA), which increases the bond strength of sodium hypochlorite (NaOCl) treated root dentin.

Pit and fissure sealant: Curcumin induces reduction of caries by its anti-microbial properties. This sealant can be made from a combination consisting of a polymerizable resin framework composed of acrylic monomer and group composed of Annatto extract, turmeric extract, and Apo-8-Carotenal.⁴³

Role of antioxidants in orthodontics

The use of a topical antioxidant essential oil gel in orthodontic patients with gingivitis has been found to be an effective way of reducing inflammation. Pine bark extract can increase bond strength of brackets attached to bleached human tooth enamel. Statistically significant findings about bone formation were obtained when vitamin C and resveratrol were used in pre-maxillary suture expansion.

Role of antioxidants in oral surgery

Green tea

Anti-inflammatory properties at the inflammation site were shown by aromatic components of green tea. Green tea extract effectively reduced the postoperative pain after initiation of rinsing as indicated in a study conducted by Eshghpour et al. This may be dedicated to the anti-inflammatory activity of green tea components at the surgical site. In addition to inflammation, bacterial infection following impacted molar surgery increases postoperative pain. Green tea catechins (EGC, EGCg, and ECg) have antibacterial activity, and studies both in vitro and in vivo have shown that green tea is effective against bacteria in dental caries and periodontal diseases.⁴⁴

Vitamin K: Vitamin K serves as a promoter for the production of blood clotting factors mainly in preserving the levels of prothrombin, which is the first step in the development of a clot. Blood coagulation is impaired as a low level of prothrombin.⁴⁵

Vitamin C: In numerous bodily reactions vitamin C functions as an antioxidant. It also has various metabolic functions as a coenzyme. This is important in the production of collagen (insoluble protein of connective tissue, cartilage, and bone protein), which plays a crucial role in the healing of wounds. Vitamin C also strengthens tissue and enhances integrity of capillaries. Vitamin C promotes RBC development by enhancing the

synthesis and use of iron. Also, it makes the body use folate and vitamin B12.⁴⁵

Honey: Aleolae osteitis (dry socket) is also a frequent adverse effect related to teeth extraction. Honey's viscosity is high, and it creates a physical barrier that prevents bacterial wound colonization. Chemical debridging of the honey is effective and surgical debridging is not necessary. The antibacterial effects of honey also have been attributed to hydrogen peroxide. The hydrogen peroxide accumulates in diluted honey due to the presence of the enzyme glucose oxidase from the bee's hypopharyngeal glands. This helps with the Fenton reaction in debridging the wound; it can easily create free hydroxyl radicals with bactericidal effect. Honey's antibacterial efficacy can also be attributed to its hygroscopic properties and low pH (3.6). Bacteria become dehydrated and are dormant due to the hygroscopic properties of the honey. The viscous honey-formed barrier provides a moist atmosphere that aids in quicker healing of wounds. Honey's nutrient content, such as levulose and fructose, improves local nutrition and promotes quick epithelialization. Biochemically, the anti-inflammatory effects of honey were accompanied by a decrease in CRP values after dry sockets with honey dressing had been healed from pretreatment values.⁴⁶

Aloe Vera: Aloe Vera has very strong antioxidant nutrients. The activity of glutathione peroxidase, superoxide dismutase enzymes and a phenolic antioxidant have been detected in Aloe Vera gel, which may be responsible for these antioxidant effects. Aloe vera also contains vitamin A, C, and E. We acquire free radicals in our bodies through absorption of our skin and through digestion.⁴⁷ The findings of an in-vivo indicated that in contrast with clindamycin-soaked Gelfoam, the SaliCept patch (freeze-dried pledget containing Acemannan Hydrogel) greatly decreased the occurrence of AO.

Curcumin: Turmeric is an incredible natural spice with healing properties and is also used to cure dry sockets. This has been in use for thousands of years as a common treatment in ayurvedic medicine. Rich in curcuminoids, turmeric extract is well known for its anti-inflammatory, anti-oxidant and anti-microbial effects. Curcumin's mechanism of action can be called multicentric as it functions as an inhibitor of prostaglandin, liposomal membrane stabilizer, leucotrienes & thromboxane B4 activity inhibitor without effecting prostacycline synthesis, adrenal steroidogenesis stimulator, substance P Depletor in nerve terminals, analgesic & oxidant. Curcuma longa also contains proteins, fats which are essential in the healing and regeneration of wounds. Curcumin's anti-inflammatory effects have been shown to suppress the development of 5-lipoxygenase in rat peritoneal neutrophils, as well as the activities of 12-lipoxygenase and cyclooxygenase in human platelets. The unique potential of both pro- and antioxidants depends on their biological environment's redox state. Extensive in vitro and in vivo research has shown that turmeric inhibits the activity of the epidermal ornithine decarboxylase, the synthesis of epidermal DNA and the promotion of skin tumors in mice.⁴⁸

Limitations of antioxidants

While fruits and vegetables have multiple advantages because they help to reduce free radical harm from environmental contaminants (including radiation) in clinical research, in several in vitro and animal tests, supplements of vitamins C and E and beta-carotene typically do not reduce DNA harm from irradiation. There are fair evidence which show that vitamin C has no effect on cancer. High doses of Vitamin A showed toxic and teratogenic effects on the embryos. High doses of vitamin C can be linked with ovarian steroidogenesis and increased risk of abortion. Several findings have found

that people whose diets are high in fruits and vegetables are less likely to develop cancer and increased beta-carotene concentration in their blood. Betacarotene supplements, however, have no anticancer effect, and in addition they increase the cancer in smokers.⁷

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