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Antioxidants used in dentistry

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Abstract: Recently, many dental fields shift to the use of natural products such as antioxidants as it shows a huge effect in relieving several dental diseases.

Keywords: Antioxidants; dentistry.

Introduction

Many natural products rich in antioxidant activity are used in eliminating the reactive oxygen species and oxidative stress.

1. Reactive oxygen species

Most free-radical causing biological damage is known by Reactive Oxygen Species (R.O.S), which is an oxygen-derived molecule that comes from super-oxides and hydrogen peroxidase. They come from the surrounding atmospheric pollutants, UV light, and irradiation. It produces oxidative stress which plays a characteristic role in the formation of many diseases that may affect the oral cavity that can be prevented by using antioxidant products. (1)

2. Antioxidants

They are considered the latest interest in different fields as several factors are increasing the presence of the free radical, antioxidants are a substance known as a scavenger, it protects the body against the toxic effect of the free radical that may cause slow cell damage and harmful effect. Antioxidant materials have a wide spectrum of usage in many medical fields and clinical practice, especially in dentistry. Their usage can be assembled in the majority of the dental field in restorative, periodontics, endodontics, orthodontic, and oral maxillofacial surgery. (2)

2.(A). Mechanism of action

It has several mechanisms of action; the first form is the prevention which prevents the formation of free radicals, the second one is the chain breaking form by the termination of a chain reaction, the third one has a repair function. (1)

2.(B). Sources of antioxidants

Antioxidants can be synthesized normally in the body or obtained from multiple dietary sources, they may be endogenous obtained from enzymes, exogenous which come from outside the human body obtained from minerals,

vitamins (A, E, C), Beta-carotene, lycopene, food (plant-based food) and herbal supplements. There are many compounds has antioxidant activity derived from plants as phenolic derivatives and flavonoids as well as terpenes, catechin, tannins, and catechins. [3]

Antioxidant products can be presented mainly in different dental products such as mouth rinses, toothpaste, and oral sprays. It was found that most dental materials such as resin composite filling, dental implants, bleaching agents, dental cement, metal, ceramic restoration, and intercanal medication may form free radicals. Therefore, there are several new approaches to adding antioxidants products in many dental materials. [4]

2.(C). Most common antioxidant products used in dentistry

Ascorbic acid (vitamin C) is a water-soluble antioxidant, which is found mainly in citric fruit like orange, lemon, grapes, and colored pepper. their deficiency may affect gingival health.

Vitamin c has several modes of action on the free radicals, scavenging, preventive form. Also, it is known as an oxygen scavenger antioxidant as it reacts with oxygen. [1]

α-tocopherol (vitamin E) is a lipid-soluble antioxidant, it is derived from unsaturated fats, olives, and oils. It presents normally in body plasma and is diminished in smokers. It can maintain cell membrane integrity. But It depends on another antioxidant for its action as ascorbic acid. It has an abundant role in chain breaking as an antioxidant. [1]

Carotenoids are a huge family of antioxidants. They are highly found in red, yellow fruits and vegetables such as carrots and pumpkin. They are classified as lycopene, α-carotene, β-carotene, and retinol. While Polyphenols are found naturally in vegetables, fruits, and green tea. They are Composed of huge compounds, most common (flavonoids, anthocyanins, catechin). They act as a free radical scavenger. [5]

Aloe Vera is a natural plant which has a medicinal effect, it is derived from the Asphodelaceae family and the genus 'Aloe'. Aloe Vera Barbadensis is the most common and useful species, showing a wide variety of uses, especially as an antioxidant in different dental applications. It is provided in many forms: gel, spray, added to toothpaste, mouth rinses, and several dental materials.

It blocks mainly the radical effect by donating a hydrogen atom. Aloe Vera shows wide application as an antioxidant after extraction due to its wound healing activity, used after tooth bleaching to eliminate the harmful effect of hydrogen and carbamide peroxide that may affect enamel and dentin, and it plays a significant role in treating aphthous stomatitis. [6][7][8]

Propolis is derived from bees and has various uses in dentistry in the relief of dentin hypersensitivity. in addition to that, It can be used as pulp capping material and contains caffeic acid phenethyl ester which affects bone healing. [9]

3. Antioxidant materials used in restorative dentistry

3. (A). Role of antioxidants on dental caries prevention

Researches and studies exhibit those cranberries specifically their Type A oligomers and their role in dental caries prevention, which is caused by Streptococcus mutans which is one of the most common bacteria that induce caries formation and propagation. [10]

Eugenol has been already used in controlling toothache, it contains an enzyme activator for antioxidant effect. [11] Additionally, natural polyphenols in tea in large volumes as Epigallocatechin-3-gallate play a role in minimizing dental cavities and plaque formation. [2]

Antioxidant has relevant effects on remineralization of the carious tooth, dentin hypersensitivity, pulp capping, and bond strength after teeth bleaching. [10]

3.(B). Role of antioxidants on remineralization of carious tooth

In vitro study based on grape seeds that contain Proanthocyanidin (PA) combined with fluoride done on a sampled tooth, by comparing it to another untreated tooth, the result shows higher remineralization power on carious enamel and dentine. This is because of ceasing the carious propagation by adding calcium and phosphate ions to be deposited on the demineralized enamel. (12)

According to Hiraishi et al. study, Hesperidin found in Flavonic acid enhances remineralization of dentin lesions compared to chlorohexidine, this is because it protects the collagen structure of dentin, the study based on several samples that subjected to low PH solution for 14 hours to ensure the demineralization, then incubated in a solution of hesperidin and another one of chlorohexidine for 2 hours, by observing the results reveal that the sample in hesperidin solution has the lowest mineral loss due to stopping the demineralization process. (13)

3. (C). Role of antioxidants on treating Dentin hypersensitivity

Many approaches are done to occlude the exposed dentin with a certain material to decrease the pain, based on the hydrodynamic theory that state that unprotected dentin cause sharp pain and unpleasant sensation to the patient when subjected to any stimulus as chemicals, and thermals. (10)

Dentinal tubules occlusion can be done by laser, dentin sealer, toothpaste containing desensitizing agents such as potassium fluoride, or varnish.

Some treatment modalities include using antioxidant products to reveal the reduction of dentin hypersensitivity in a short time, the result can be shown in two days to two weeks. (10)

Propolis shows a huge impact in desensitization of dentin, in vivo study was done on 40 different patients complaining of dentin hypersensitivity, by comparing the effect of propolis with potassium nitrate and sodium fluoride and another desensitizing agent. The visual analog scale (VAS) was used to record the baseline measurement for pain due to hypersensitivity. After 7 days, the final score was collected again after the application of the appropriate desensitizing agent. The result shows that all of them have a potent effect but propolis has a rapid tendency in stopping the dentin hypersensitivity. (14)

3. (D). Role of antioxidants as pulp capping material

Reports of a split-mouth study carried on pigs provided propolis that has an excellent pulp capping ability and high-quality formed dentin compared to calcium hydroxide. The first step done in the study is removing the tooth crown and sealing the cavity using the testing materials then by scarifying some of the pig on the 10^{th}, 15^{th}, and the 30^{th} days, the sectioning teeth were detected under a light microscope by using H&E stain.

The result shows that propolis form high-quality dentin and the pulp remains vital, while calcium hydroxide shows a porous reparative dentin, although it is the most used pulp capping material it shows drawback of its solubility. (15)

3. (E). Role of antioxidants on the bond strength after tooth bleaching

In the past the bleaching process should be preceded by restoring the carious or broken teeth because free radicals interrupt the bond strength of the restoration, now restoring the tooth can be done after bleaching by 24 hours to 3 weeks. Because of the power of Sodium Ascorbate, α-tocopherol, and Proanthocyanidin in neutralizing the free radical produced from carbamide peroxide or hydrogen peroxide decomposition after the bleaching process. (10)

Several studies and research assure the success of antioxidant activity by adding Grape seed or pine bark extract solutions to bond material to enhance some of their properties by increasing its bond strength which usually decreases after the bleaching process.

Another experimental study was done in vitro by using anterior extracted tooth, then preparing it to a bleaching process, and comparing it with two control groups one with laser bleaching, then by the application of antioxidant product

especially ascorbic acid, α-tocopherol, hesperidin before using a bonding agent and composite restoration. The results show great success after testing the shear bond strength, as they eliminate the oxidative effect of bleaching. (16)

4. Antioxidant materials used in periodontics

Human saliva considers a natural antioxidant compound, it is observed by studying salivary components that it is rich in uric acid, albumin, ascorbic acid, glutathione, and antioxidant enzymes. This facilitates the salivary functions in lubricating the oral cavity that led to a reduction in plaque and bacterial retention hence, decreasing dental caries formation, protecting oral mucosa, and maintaining oral health. (17)

An in-vitro study based on cranberry components shows their potent role in blocking the formation of Porphyromonas gingivalis which is a prominent pathogen that causes chronic periodontitis. the researcher used microplate assay and investigation of cranberry solution on the cell by using a scanning electron microscope. The result shows the ability of cranberry in reducing the quantity of p.gingivalis to aggregate in the periodontal site. (18)

Another experiment that depends on using vitamin E reveals its antioxidant effect on reducing periodontitis although it does not affect alveolar bone loss.

Also, Aloe Vera has an antioxidant effect on relieving oral ulcers and enhancing their healing. Therefore, maintaining good nutrients, vitamins, and antioxidant products in form of mouthwash and toothpaste can control the reduction of periodontal and gingival diseases. (19)

5. Antioxidant material used in Endodontics

Lycopene as well as Aloe Vera has a sedative effect as an antioxidant material therefore, it is used as dressing in root canal treatment and an intracanal medication.

In vitro study based on using a mixture of proanthocyanidin (grape seed extract) and lycopene to evaluate their effect when used as intracanal medication. Four samples of the mixture were used then the antibacterial property was tested using the agar diffusion method. The result proved that lycopene shows more antioxidant properties when compared to proanthocyanidin as intracanal medication. (20)

6. Role of antioxidants in preventing and treating oral cancer

Dietary antioxidants consider a preventive and therapeutic method of oral cancer. Research on animals stated the successful modalities of antioxidants intake in inhibiting oral cancer and decreasing oral carcinoma growth, Antioxidants have the ability of shielding lipids and other membrane molecules against oxidative damage by absorbing oxidants before they can cause tissue damage.

β-carotene and vitamin E have a significant role in controlling oral cancer, in 1960 vitamin E was the best option for treating oral leukoplakia by studying also lycopene and β-carotene it was found that they have a therapeutic effect on oral leukoplakia. (2) (21)

Also, Retinoids as well as aloe vera and has potent antioxidant activity on treating Oral Lichen Planus systemically or topically. (7)

There is a study to evaluate the effect of aloe vera on oral lichen planus (OLP) done on 21 female patients with OLP , they are grouped into three groups, the first two groups received the aloe vera gel with different concentrations on the lesion, while the third one has received the placebo and is considered as a control group, each group was instructed to use the aloe vera gel twice a day on the dry lesion after meals, baseline measurement of pain was taken before and after treatment using the visual analog scale, the size of the lesion was measured quantitatively using a calibrated grid, the result show improvement and reduction in the size of the lesion with the first two groups. (22)

7. Role of antioxidant material used in bone formation

Alveolar bone loss considers as one of the common diseases that affect the oral cavity and has a bad effect on different aspects, scientists use mice and small animals to study the effect of ROS and oxidative stress on the formation of alveolar bone loss and the initiation of peri-implantitis, which is formed in the subgingival region due to aggregation of anaerobic bacteria. (2)

Grape seed and propolis specifically caffeic acid phenethyl ester have a noticeable enhancement of bone formation and healing, therapeutic action on peri-implantitis in the animal study. (2)

In vivo study done on male rats with a bone defect, they are divided into three groups one for control and the other two groups with the testing materials, an incision is done after anesthetizing the rats, bone drilling was done with continuous irrigation then bone graft added with the testing materials and sutures were done in the periosteum and skin, followed by a single dose antibiotic injection, follow up is done and by scarifying seven rats on 7^{th}, 15^{th} and 30^{th} day, the histopathological evaluation shows bone regeneration and healing enhancement from caffeic acid phenethyl ester. (23)

Also, eugenol is used in rapid wound healing, in paste form as a dressing material after tooth extraction. (11)

More research and studies are needed to elaborate the mystery of the side effect of antioxidants, the average dose, and the quantity to be used and added in dental material. Since high doses may have serious health complications such as teratogenicity and toxicity. Most of the studies done using antioxidants are in vitro or on animals, further clinical trials are needed to help their progress in the dental field. (2)(19)

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