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Review Article

# Dietary antioxidants and their indispensable role in periodontal health

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ABSTRACT

Periodontitis is an increasing area of interest due to its global prevalence. This inflammatory condition results due to the loss of the critical balance between the virulence factors produced by microorganisms and the inflammatory host response. A number of efforts have been made in the past to address this condition and regain periodontal health. Targeting the root cause by nonsurgical debridement has been considered the gold standard. However, research has shown the possible effects of nutrient deficiency and an imbalanced diet on the periodontium. Therefore, an effort toward the maintenance of optimal conditions as well as improvement of the oral health necessities the introduction of adjunctive nutritional therapy, which can benefit the patients. Antioxidants in the diet have some remarkable benefits and valuable properties that play an irreplaceable role in the maintenance of periodontal health. These have emerged as excellent adjuncts that can enhance the outcomes of conventional periodontal therapy. The aim of this review article is to highlight some of these dietary antioxidants that can make a notable difference by striking a balance between health and disease.



## 1. Introduction

Periodontitis is a ubiquitous chronic inflammatory disease affecting the supporting tissues of the teeth. It is one of the most common chronic diseases affecting humans. The disease is caused by infection induced by specific microorganisms or a group of microorganisms, which eventually causes progressive destruction of the periodontal ligament (PDL) and alveolar bone. The progression of this destructive disease appears to be dependent on abnormal host response to the biofilm organisms [1]. The periodontitis phenotype is characterized by hyperinflammation involving excess release of oxygen-free radicals by inflammatory cells, especially polymorphonuclear leucocytes (PMNLs) [1]. PMNLs are the first line of defense against any microbial invasion. In the event of a

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microbial attack, there is a burst of $O_2$ consumption (i.e., nonmitochondrial) at about 10 or 20 times that of resting consumption. This burst of oxygen consumption is the "respiratory burst" phenomenon, and the excessive uptake of oxygen in neutrophils and macrophages generates SO anion radicals, $H_2O_2$, hydroxyl radicals, and HOCl, all of which are capable of damaging either cell membranes or associated biomolecules. These are in fact the free radicals (FRs) or reactive oxygen species (ROS) capable of inducing tissue damage and cell destruction. Well-being of the organism depends on the activity of efficient defense mechanisms against oxidative damage induced by FRs/ROS. Antioxidants provide this defense and protection. They also counteract the destructive effects of ROS and help to maintain homeostasis in the body.

It is believed that although the primary etiological agent of the disease is specific, predominantly Gram-negative anaerobic or facultative bacteria within the subgingival biofilm [2], the majority of periodontal tissue destruction is caused by an inappropriate host response to those microorganisms and their products [3]. If this inappropriate host response is not addressed and disease is not promptly recognized and managed, it can cause tooth loss, resulting in compromised masticatory function and subsequent alterations in the dietary intake and malnutrition status.

Antioxidants, in particular, dietary antioxidants, have a protective effect on the periodontium. They neutralize the FRs, ROS, and reactive nitrogen species that can cause oxidative stress, which results in periodontal breakdown and excessive tissue damage. With growing age, vitamins and minerals, the essential constituents of food, are less efficiently absorbed and their production within the body declines, thereby increasing the risk of inflammatory burden. Dietary antioxidants include certain vital vitamins and minerals as well as certain important phytochemicals that help to keep the periodontal damage at bay. In fact, they can protect our cells from almost all of the diseases associated with inflammation and the aging process. Because of its association with several other systemic disorders, periodontitis has become a crucial area to deal with.

Many risk factors that modify the host response and thereby tip the balance from health to disease have been identified. These factors can be classified as genetic, environmental (e.g., stress, bacterial challenge), and lifestyle/behavioral (e.g., exercise, nutrition, smoking). Moreover, periodontal disease has been a prominent risk factor for a number of systemic diseases such as cardiovascular disease, diabetes, and rheumatoid arthritis [4–7]. Therefore, considering the significance of nutrition and the need to maintain optimal antioxidant levels for the maintenance of periodontal health, natural antioxidants as potential adjuncts are now gaining increased attention. These antioxidants, which are critical in maintaining an optimum level of health, can be easily obtained through our daily dietary intake. This adjunctive effort with appropriate nutritional supplementation is vital to halt the progression of this inflammatory condition. Thus, to appreciate the valuable effect of dietary antioxidants on periodontal health, we herein discuss the vital roles of few assorted antioxidants in the maintenance of optimum oral health; additionally, we also discuss how the nutritional status would assist in controlling the complex nature of the periodontal disease and striking a balance between health and disease.

## 2. Discussion

### 2.1. *Neutrophils as mediators of inflammation*

PMNLs play a vital role in host defense and constitute the first line of defense against microbial invasion and infection in the body. In the oral cavity, following plaque accumulation and the development of clinical inflammation, 90% of leukocytes that enter the gingival crevicular fluid (GCF) and 50% of those that infiltrate junctional epithelium are PMNLs [1]. These neutrophils help in controlling the microbial invasion by several intracellular and extracellular oxidative and nonoxidative killing mechanisms [8]. This oxidative killing mechanism of neutrophils leads to the formation of ROS/FRs.

### 2.2. *Free radicals*

An FR may be defined as an atomic or molecular species capable of independent existence with one or more unpaired electrons in its structure [9]. These FRs at low concentrations are involved in performing various cell signaling functions but at higher concentrations, they react with certain cellular components such as DNA, proteins, lipids exerting an oxidative stress in the gingival tissues, PDL, and alveolar bone and mediate tissue damage. Hence, to maintain the biological balance, antioxidants come into play.

### 2.3. *Antioxidants*

An antioxidant is any substance that when present at concentrations below those of their oxidizable substrate significantly delays or prevents oxidation of that substrate [10]. Several biologically important compounds have been shown to possess antioxidant properties, including vitamin C (ascorbic acid), vitamin E (α-tocopherol), vitamin A, β-carotene, metallothionein, polyamines, melatonin, nicotinamide adenine dinucleotide phosphate, adenosine, co-enzyme Q-10, urate, ubiquinol, polyphenols, flavonoids, phytoestrogens, cysteine, homocysteine, taurine, methionine, S-adenosyl-L-methionine, resveratrol, nitroxides, reduced glutathione (GSH), glutathione peroxidase, superoxide dismutase [11], catalase, nitric oxide synthase, heme oxygenase-1, and eosinophil peroxidase [12].

These are essential for a range of biological processes important in supporting optimal health. Baumgartner et al [13] carried out a study on the effect of Stone Age diet on the oral conditions in the absence of any oral hygiene measures. Ten volunteers residing in a Stone Age setup were included in the study for a period of 4 weeks. The volunteers were placed on a primitive diet, which was high in fiber, antioxidants, and fish oils, but low in refined sugars and with no oral hygiene measures. Clinical parameters such as bleeding on probing, gingival and plaque indices, and probing depth were studied and reported at baseline and at 4 weeks. As would be expected, plaque levels increased significantly and classic periodontal pathogens emerged within the biofilm, but