The Role of Antioxidants in Managing Oral Inflammation: A Biochemical Perspective

-By Dr. Devlina Ghosh, 20th March 2025

Oral inflammation is a widespread issue that affects millions of people, leading to conditions such as gingivitis and periodontitis. These conditions are primarily driven by an overactive immune response to harmful bacteria in the mouth, resulting in oxidative stress and tissue destruction. While conventional treatments include mechanical cleaning and antimicrobial agents, emerging research highlights the role of antioxidants in reducing inflammation at a biochemical level.

Inflammation in the mouth is largely driven by oxidative stress, which occurs when there is an imbalance between harmful reactive oxygen species (ROS) and the body's ability to neutralize them. When harmful bacteria accumulate on the gums, the immune system releases pro-inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6). These molecules trigger an inflammatory response, leading to gum swelling, redness, and tissue destruction. Furthermore, matrix metalloproteinases (MMPs)—a group of enzymes responsible for breaking down connective tissue—become overactive in response to chronic inflammation, causing damage to oral tissues.

This is where antioxidants come into play. By neutralizing ROS, modulating cytokine activity, and inhibiting tissue-damaging enzymes, antioxidants can help control inflammation and prevent further damage.

Neutralizing Oxidative Stress

One of the primary roles of antioxidants is to scavenge free radicals, preventing them from damaging gum tissues. Antioxidants such as vitamin C, vitamin E, and glutathione help maintain the balance between ROS production and elimination, reducing oxidative stress in the gums.

- **Vitamin C** acts as a powerful antioxidant by donating electrons to neutralize free radicals, thus preventing oxidative damage to oral tissues.
- **Vitamin E** protects cell membranes from lipid peroxidation, a process that weakens gum tissue integrity.
- **Glutathione**, a naturally occurring antioxidant in the body, helps repair damaged tissues and strengthens the body's defence against oxidative damage.

Regulating Inflammatory Pathways

Certain antioxidants actively regulate the body's inflammatory response by inhibiting key signaling pathways like nuclear factor kappa B (NF-κB), which plays a central role in inflammation.

- Polyphenols from green tea and curcumin (found in turmeric) have been shown to suppress NF-κB activation, reducing the production of pro-inflammatory cytokines such as IL-1β and TNF-α.
- Quercetin, a flavonoid found in apples and onions, has been found to decrease cytokine activity and stabilize mast cells, preventing excessive inflammation.

Antioxidants play a crucial biochemical role in managing oral inflammation by reducing oxidative stress, modulating inflammatory pathways, and supporting tissue repair. While traditional treatments for gum disease focus on mechanical cleaning and antimicrobials, incorporating antioxidant-rich foods, supplements, and oral care products can be a powerful complementary strategy for maintaining gum health.

References:

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