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The Battle of the Microbiome: The Synergistic Relationship Between Oral Health and Nutrition

Oral Dysbiosis

Oxidative Stress: Inflammation, Tissue Damage, Collagen Degradation, Gingival Bleeding, Impaired Antioxidant Defense Mechanisms, Bone Resorption, Impaired Wound Healing

Bassani B, Cucchiara M, Butera A, et al. Neutrophils' Contribution to Periodontitis and Periodontitis-Associated Cardiovascular Diseases. *Int J Mol Sci.* 2023;24(20):15370. Published 2023 Oct 19. doi:10.3390/ijms242015370

Polyphenols

Berries, cocoa powder & dark chocolate, capers, black olives, nuts, plums, sweet cherries, cloves

Guo Y, Li Z, Chen F, Chai Y. Polyphenols in Oral Health: Homeostasis Maintenance, Disease Prevention, and Therapeutic Applications. *Nutrients.* 2023;15(20):4384. Published 2023 Oct 16. doi:10.3390/nu15204384

Liu Z, Ren Z, Zhang J, et al. Role of ROS and Nutritional Antioxidants in Human Diseases. *Front Physiol.* 2018;9:477. Published 2018 May 17. doi:10.3389/fphys.2018.00477

Belfiore E, Di Prima G, Angellotti G, Panzarella V, De Caro V. Plant-Derived Polyphenols to Prevent and Treat Oral Mucositis Induced by Chemo- and Radiotherapy in Head and Neck Cancers Management. *Cancers (Basel).* 2024;16(2):260. Published 2024 Jan 6. doi:10.3390/cancers16020260

Macro/Micronutrients and Elements

<https://u.pcloud.link/publink/show?code=XZOPV70Zu51I3HXdvqR98mEe12grNRewvaBy>

Calcium: Essential for strong teeth and bones, deficiency can lead to tooth decay and periodontal disease.

Seeds, cheese (parmesan the most), yogurt, sardines and canned salmon (oily fish protein and Omega 3's), beans and lentils

Phosphorus: Works with calcium to build strong teeth; deficiency can cause weakened dental structures.

Hemp, flax and pumpkin seeds, oats, sardines, almonds and parmesan

Magnesium: Supports enamel formation and dental health; low levels may contribute to periodontal disease

Dark chocolate, avocado, nuts, tofu, legumes, seeds

Fluoride: Strengthens tooth enamel & prevents cavities; excess can cause fluorosis.

Black tea, grape juice, soda, blue crab, table wine, coffee, raisins

Iron: Vital for immune function; deficiency can lead to oral sores, inflammation, & increased risk of infection.

Heme iron (better absorption) liver, meat, poultry and seafood

Non-heme iron (beans), nuts, seeds, spinach and potatoes, fortified sources - tofu, grains, bread and cereal

Zinc: Important for immune function & wound healing; deficiency can cause taste disturbances and delayed healing.

Meat, shellfish, legumes, seeds, nuts, dairy, eggs

Copper: Plays a role in collagen formation; deficiency may affect gum & tissue health.

Oysters, nuts, seeds, shitake mushrooms, lobster, liver, leafy greens and dark chocolate

Selenium: Antioxidant properties help protect oral tissues; deficiency can impair immune response.

Brazil nuts, tuna, sardines, halibut, roasted ham, shrimp, turkey, beef liver

Jayasinghe TN, Harrass S, Erdrich S, King S, Eberhard J. Protein Intake and Oral Health in Older Adults-A Narrative Review. *Nutrients*. 2022;14(21):4478. Published 2022 Oct 25. doi:10.3390/nu14214478

Micronutrients

Vitamin A, D, E, K, (fat soluble) B1, B2, B3, B6, B12, biotin C, Water soluble) folic acid, pantothenic acid

Vitamins and Wound Healing

Vitamin A assists with collagen deposition, strengthening matrix structure, and building healthy epithelial tissue. Low levels increase infection risk by compromising the body's inflammatory response & immune function. In injured tissue, vitamin A promotes efficient wound healing by stimulating cell turnover.

Dietary Sources of Vitamin A: liver, egg yolks, carrots, squash, sweet potatoes, broccoli, spinach

Vitamin D is crucial for calcium & phosphorus metabolism, essential for strong bones & fall prevention. Also promotes immune function, enhances glycemic control, & reduces inflammation, aiding in wound healing

Dietary Sources of Vitamin D: fortified dairy products, sardines, tuna, beef liver, egg yolks

Vitamin E an antioxidant that regulates inflammation and encourages fast wound healing. It also aids immune function, supports connective tissue growth factor, and protects vitamins A and C.

Dietary Sources of Vitamin E: sunflower seeds, almonds, hazelnuts, olive oil, peanut butter, green leafy vegetables

Vitamin K essential for blood clotting & should be monitored when taking blood thinners like Coumadin. Also supports vitamin D & calcium in strengthening bones, regulates inflammation, & promoting faster wound healing by maintaining healthy blood vessels for effective oxygen & nutrient delivery.

Dietary Sources of Vitamin K: kale, spinach, turnip greens, Swiss chard, spring onions, cabbage, brussels sprouts, broccoli

Vitamin K1 and K2

Vitamin K1 is primarily responsible for blood clotting, Vitamin K2 is more involved in regulating calcium metabolism, hormones, supporting bone & CV health

Vitamin K2 plays a key role in healthy tooth enamel & dentin immune response

K1 plant foods, K2 fermented foods & animal products

Dr. Steven Lin: *The Dental Diet*

<https://www.drstevenlin.com/vitamin-k2-benefits>.

Vitamin C, a powerful immune-boosting antioxidant, fights infection, reduces inflammation, and neutralizes free radicals. It is essential for wound healing, aiding in iron supply to the wound bed, collagen synthesis, fibroblast function, and new blood vessel construction.

Dietary Sources of Vitamin C: citrus, tomatoes, peppers, strawberries, kiwi, guava, pineapple

Jayasinghe TN, Harrass S, Erdrich S, King S, Eberhard J. Protein Intake and Oral Health in Older Adults-A Narrative Review. *Nutrients*. 2022;14(21):4478. Published 2022 Oct 25. doi:10.3390/nu14214478

The body needs B vitamins to produce energy from glucose, amino acids, & fat. Also, for collagen fiber cross-linking in tissue rebuilding. B vitamins include B1 (thiamine), B2 (riboflavin), B3 (niacin), B6 (pyridoxine), folate, & B12. Deficiencies can delay wound healing & cause new wounds.

Dietary Sources of B Vitamins: chicken, pork, fish, eggs, dairy, legumes, enriched breads/cereals

Mi N, Zhang M, Ying Z, Lin X, Jin Y. Vitamin intake and periodontal disease: a meta-analysis of observational studies. *BMC Oral Health*. 2024;24(1):117. Published 2024 Jan 20. doi:10.1186/s12903-024-03850-5

Nutrients Oral and Dental Complications

Vitamin B12 - Angular cheilosis, halitosis, bone loss, gingivitis, separation of periodontal fibers, aphthous ulcers, caries

Proteins - Plays a role in tooth eruption, tooth size, enamel recovery, salivary gland function, response to infection, healing of oral soft tissue, & maintenance of saliva's antibacterial qualities

Vitamin D - Periodontitis, increased oral cavity inflammation, gingivitis, peri coronal bone loss

Calcium - Osteoporosis of the jaw bones

Iron - Dysphagia, angular cheilosis, recurrent aphthous ulcers, atrophy of the lingual papillae, glossitis, angular stomatitis, painful tongue with a burning sensation, suppressed immune response of oral soft tissue, burning and redness of the tongue, and paleness of the gingiva and lips

Selenium - Periodontal disease, oral cancer, impaired wound healing, developmental anomalies of the tooth, dental caries

Zinc - Decrease in taste sensation (ageusia), changes to the epithelium of the tongue, increase in cell numbers, fattened filiform papillae, ulcers, and xerostomia, delayed wound healing

Sleep

<https://www.ncbi.nlm.nih.gov/pubmed/28686746>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6213953/>
<https://www.ncbi.nlm.nih.gov/pubmed/23558409>
<https://www.ncbi.nlm.nih.gov/pubmed/26414899>
<https://www.ncbi.nlm.nih.gov/pubmed/16166580>
<https://www.sciencedirect.com/science/article/pii/S0166432811006863>
<http://learnmem.cshlp.org/content/20/10/558.full>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2793876/>
<https://www.ncbi.nlm.nih.gov/pubmed/26234117>
<https://www.ncbi.nlm.nih.gov/pubmed/20073373>
<https://www.ncbi.nlm.nih.gov/pubmed/16439717>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3703747/>
<https://www.ncbi.nlm.nih.gov/pubmed/25724146>
<https://lpi.oregonstate.edu/mic/vitamins/vitamin-B6>
<https://www.ncbi.nlm.nih.gov/pubmed/26648330>
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0103490>
<https://pubmed.ncbi.nlm.nih.gov/26648330/>

B6

Bananas, carrots, spinach, potatoes milk, eggs, cheese, fish, and whole grains. If you're considering a B6 supplement, it's important to work with your doctor. Excessive levels of Vitamin B6 can be toxic and has also been linked to insomnia

B12

Higher levels of vitamin B12 have been connected to a lower risk of depression
Connection b/t low vitamin B12 & insomnia, other studies show higher levels linked to sleep disruption & shorter sleep times

Bouloukaki I, Lampou M, Raouzaïou KM, Lambraki E, Schiza S, Tsiligianni I. Association of Vitamin B12 Levels with Sleep Quality, Insomnia, and Sleepiness in Adult Primary Healthcare Users in Greece. *Healthcare (Basel)*. 2023;11(23):3026. Published 2023 Nov 23. doi:10.3390/healthcare11233026

CoQ10

Decreases gum inflammation, good for heart health, brain & muscles. Helps heal our gums after periodontal therapy. It fights oral bacteria decreases inflammation, helps maintain healthy teeth. Deficiencies: Bad breath, decay, dry mouth, & PD. Physical and mental fatigue, tired on waking, memory confusion, difficulty concentrating.

Dietary Sources Fatty fish, organ meats, beef, sardines, peanuts

Collagen

Strengthens enamel, improves wound healing, gum health, and is essential for maintaining and repairing connective tissue.

Deficiencies: brittle teeth, receding gums, and mouth sores

Dietary Sources Sardines, organ meats, gelatin, eggs, beef, chicken with skin, bone broth

Dragsbæk K, Neergaard JS, Hansen HB, et al. Matrix Metalloproteinase Mediated Type I Collagen Degradation - An Independent Risk Factor for Mortality in Women. *EBioMedicine*. 2015;2(7):723-729. Published 2015 Apr 30. doi:10.1016/j.ebiom.2015.04.017

Cabral-Pacheco GA, Garza-Veloz I, Castruita-De la Rosa C, et al. The Roles of Matrix Metalloproteinases and Their Inhibitors in Human Diseases. *Int J Mol Sci*. 2020;21(24):9739. Published 2020 Dec 20. doi:10.3390/ijms21249739

L-arginine - Amino acid - biofilm manager, buffers pH, reduces thickness & density. Helps remineralize teeth, can reverse & prevent tooth decay. Saliva supplemented with arginine resists the pH lowering, reducing the risk of demineralization of tooth surfaces.

Deficiency: Poor wound healing, diminished insulin production, atherosclerosis, high blood pressure, skin rash and loss of hair.

Dietary Sources Meats, fish, nuts, seeds, and legumes

Schulman SP, Becker LC, Kass DA, et al. L-arginine therapy in acute myocardial infarction: the Vascular Interaction With Age in Myocardial Infarction (VINTAGE MI) randomized clinical trial. *JAMA*. 2006;295(1):58-64. doi:10.1001/jama.295.1.58

Böger RH. Asymmetric dimethylarginine (ADMA) and cardiovascular disease: insights from prospective clinical trials. *Vasc Med*. 2005;10 Suppl 1:S19-S25. doi:10.1177/1358836X0501000104

Böger, R. H. (2006). Asymmetric dimethylarginine (ADMA): A novel risk marker in cardiovascular medicine and beyond. *Annals of Medicine*, 38(2), 126–136. <https://doi.org/10.1080/07853890500472151>

Zhou, S., Zhu, Q., Li, X. et al. Asymmetric dimethylarginine and all-cause mortality: a systematic review and meta-analysis. *Sci Rep* 7, 44692 (2017). <https://doi.org/10.1038/srep44692>

Omega's

Van Ravensteijn MM, Timmerman MF, Brouwer EAG, Slot DE. The effect of omega-3 fatty acids on active periodontal therapy: A systematic review and meta-analysis. *J Clin Periodontol*. 2022;49(10):1024-1037. doi:10.1111/jcpe.13680

Sun M, Zhou Z, Dong J, Zhang J, Xia Y, Shu R. Antibacterial and antibiofilm activities of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) against periodontopathogenic bacteria. *Microb Pathog*. 2016;99:196-203. doi:10.1016/j.micpath.2016.08.025

Choi J.-S., Park N.-H., Hwang S.-Y., Sohn J.H., Kwak I., Cho K.K., Choi I.S. The antibacterial activity of various saturated and unsaturated fatty acids against several oral pathogens. *J. Environ. Biol*. 2013;34:673–676

Xylitol

Xylitol is non-fermentable and reduces the production of acidic byproducts helping to maintain a more neutral pH. Increases salivary flow. In the remineralization process it contributes to a more stable pH

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10098279/>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7693686/>

Salli K, Lehtinen MJ, Tiihonen K, Ouwehand AC. Xylitol's Health Benefits beyond Dental Health: A Comprehensive Review. *Nutrients*. 2019;11(8):1813. Published 2019 Aug 6. doi:10.3390/nu11081813

Bone health, diabetes, anti-inflammatory, ear health, candida, dermatological

Marco Witkowski, et al., Xylitol is prothrombotic and associated with cardiovascular risk, *European Heart Journal*, 2024;, ehac244, <https://doi.org/10.1093/eurheartj/ehac244>

Giacaman RA. Sugars and beyond: the role of sugars and the other nutrients and their potential impact on caries. *Oral Dis.* 2018;24:1185–1197.
Featherstone JD. Prevention and reversal of dental caries: role of low-level fluoride. *Community Dent Oral Epidemiol.* 1999;27:31–40.
Marsh PD. Are dental diseases examples of ecological catastrophes? *Microbiology.* 2003;149:279–294.
König KG. Diet and oral health. *Int Dent J.* 2000;50:162–174.

This is a terrific PDF to show all the pH Values of Common Foods and Ingredients

https://www.clemson.edu/extension/food/food2market/documents/ph_of_common_foods.pdf
https://webpal.org/SAFE/aaarecovery/2_food_storage/Processing/lacf-phs.htm
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8408322/>
<https://pubmed.ncbi.nlm.nih.gov/30568387/>
<https://pubmed.ncbi.nlm.nih.gov/32106720/>
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6352572/>
<https://jissn.biomedcentral.com/articles/10.1186/s12970-016-0153-8>

Antimicrobials

In vitro data shows the adaptation and cross-adaptation of oral pathogens to antiseptics and antibiotics

Adaptation: Oral pathogens are capable of developing resistance or tolerance to antiseptics and antibiotics. Over time, the pathogens change in a way that allows them to survive the presence of the substances that were once effective against them.

Cross-adaptation: The adaptation to one substance (e.g., an antiseptic) may confer some level of resistance or tolerance to another, typically unrelated substance (e.g., an antibiotic). This can occur through various mechanisms, such as changes in the pathogen's genetic makeup or the activation of certain defense mechanisms that provide broad-spectrum resistance.

<https://www.rdhmag.com/patient-care/article/55247380/antimicrobial-resistance-and-its-effects-on-the-periodontal-environment>

Verspecht, T., Rodriguez Herrero, E., Khodaparast, L. et al. Development of antiseptic adaptation and cross-adaptation in selected oral pathogens in vitro. *Sci Rep* 9, 8326 (2019). <https://doi.org/10.1038/s41598-019-44822-y>
Lepelletier D, Maillard JY, Pozzetto B, Simon A. Povidone Iodine: Properties, Mechanisms of Action, and Role in Infection Control and Staphylococcus aureus Decolonization. *Antimicrob Agents Chemother.* 2020;64(9):e00682-20. Published 2020 Aug 20. doi:10.1128/AAC.00682-20
Jefri UHNM, Khan A, Lim YC, et al. A systematic review on chlorine dioxide as a disinfectant. *J Med Life.* 2022;15(3):313-318. doi:10.25122/jml-2021-0180

Essential Oils

Radu CM, Radu CC, Bochiş SA, et al. Revisiting the Therapeutic Effects of Essential Oils on the Oral Microbiome. *Pharmacy (Basel).* 2023;11(1):33. Published 2023 Feb 10. doi:10.3390/pharmacy11010033
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9958697/>

EOs aka volatile oils synthesized from plants. Main composition hydrocarbon terpenes and terpenoids.

EOs other common compounds alcohols, acids, esters, epoxides, aldehydes, ketones, amines, sulfides, oxides, fatty acids, other sulfur derivatives

Cavities: Clove oil, Sesame oil, Cinnamon oil, Sumac oil, Citrus oil Antibacterial, antimicrobial, antifungal, anticarcinogenic, anti-adhesion properties

Perio: Clove oil, Lavender oil, Lemongrass oil, Eucalyptus oil Anti-inflammatory, antibiofilm growth effect

Pain: Clove oil, Lavender oil Anxiolytic, analgesic-like effect, anti-inflammatory

Oral Cancer: Clove oil, cinnamon oil, Anti-inflammatory, antimutagenic cytotoxic, immunomodulatory

Dental Fields: Odontology, Periodontics, Endodontics, Surgery

Therapeutic effects: Anti-inflammatory, antimicrobial, antitumor, antibacterial, antifungal

Most Common in Dentistry:

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9958697/>

Curcuma Oil: antimicrobial, antiviral

Citrus Oil: antianxiety, antimicrobial, decreases tooth decay, reduces plaque adherence

EOs from propolis residues: antibacterial, antimicrobial, antioxidant

Thyme oil: antifungal, antiviral (HSV 1 virus), bacteriostatic

Sesame oil: antifungal, antimicrobial, antiviral, reduces plaque adherence

Rosemary oil: anti-inflammatory, antitumor, antiviral, bacteriostatic

Peppermint oil: antibacterial, antimicrobial, antiviral, reduces plaque adherence

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5072072/>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8152699/>

<https://doi.org/10.1155/2013/146479>

Cold Sores

Immune boosting: probiotics, vitamins E, C & zinc

Arginine is essential for HSV replication avoid arginine rich foods like nuts and chocolate

Topical application of tea tree or peppermint oil may help-virucidal activity in vitro

Lemon balm, topically, maybe effective

Becker Y, Olshevsky U, Levitt J. The role of arginine in the replication of herpes simplex virus. *J Gen Virol*. 1967;1(4):471-478. doi:10.1099/0022-1317-1-4-471

Schuhmacher A, Reichling J, Schnitzler P. Virucidal effect of peppermint oil on the enveloped viruses herpes simplex virus type 1 and type 2 in vitro. *Phytomedicine*. 2003;10(6-7):504-510. doi:10.1078/094471103322331467

Carson CF, Riley TV. Safety, efficacy and provenance of tea tree (*Melaleuca alternifolia*) oil. *Contact Dermatitis*. 2001;45(2):65-67. doi:10.1034/j.1600-0536.2001.045002065.x

Koytchev R, Alken RG, Dundarov S. Balm mint extract (Lo-701) for topical treatment of recurring herpes labialis. *Phytomedicine*. 1999;6(4):225-230. doi:10.1016/S0944-7113(99)80013-0

Wölbling RH, Leonhardt K. Local therapy of herpes simplex with dried extract from *Melissa officinalis*. *Phytomedicine*. 1994;1(1):25-31. doi:10.1016/S0944-7113(11)80019-X

Essential Oil	Key Component	Properties	Benefits
Tea Tree Oil	Terpinen-4-ol	Antiviral, Antiseptic	Effective against HSV-1, reduces cold sore symptoms
Peppermint Oil	Menthol	Antiviral, cooling	Inhibits herpes virus, soothes cold sore discomfort
Eucalyptus Oil	1,8-Cineole	Antiviral, Anti-inflammatory	Alleviates symptoms, reduces inflammation
Melissa (Lemon Balm) Oil	Citral, Citronellal	Antiviral, Soothing	Speeds up healing, reduces swelling and redness
Thyme Oil	Thymol	Antiviral, Antimicrobial	Shortens cold sore duration, prevents secondary infections
Lavender Essential Oil	Linalool, Linalyl acetate	Analgesic, Anti-inflammatory	Relieves pain, reduces inflammation
Clove Oil	Eugenol	Analgesic, Antiviral	Alleviates pain, effective against herpes simplex virus

Nitric Oxide

Dr. Nathan Bryan *The Nitric Oxide Solution The Secret of Nitric Oxide—Bringing The Science To Life*

Biochem Pharmacol. 2022;206:115325. doi:10.1016/j.bcp.2022.115325

Vasodilation- Helps relax and widen blood vessels increasing blood flow and lowers blood pressure

Neurotransmission- Involved in synaptic plasticity, memory formation and regulation of neurotransmitter release

Immune response- NO is also produced by immune cells, ie: macrophages, to help defend against pathogens. Can inhibit the growth of bacteria, viruses, and parasites.

Cell Signalling- Pathways involved in inflammation, smooth muscle contraction, and insulin secretion.

Gene Expression Regulation- Modulates through its interaction with transcription factors, influencing processes such as cell proliferation, apoptosis, and differentiation.

Cieplik F, Jakubovics NS, Buchalla W, Maisch T, Hellwig E, Al-Ahmad A. Resistance Toward Chlorhexidine in Oral Bacteria - Is There Cause for Concern?. *Front Microbiol.* 2019;10:587. Published 2019 Mar 22. doi:10.3389/fmicb.2019.00587

Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis [published correction appears in *Lancet.* 2022 Oct 1;400(10358):1102]. *Lancet.* 2022;399(10325):629-655. doi:10.1016/S0140-6736(21)02724-0

Cass Dooley MS, *Heal Your Microbiome*

The use of antibacterial mouthwash for seven days has been shown to reduce oral nitrite production by 90% and plasma nitrite levels by 25%. That same research found systolic and diastolic blood pressure elevation correlated with decreases in circulating nitrite concentrations. The loss of nitric oxide production is associated with major cardiovascular risk factors.

Kapil V, Haydar SM, Pearl V, Lundberg JO, Weitzberg E, Ahluwalia A. Physiological role for nitrate-reducing oral bacteria in blood pressure control. *Free Radic Biol Med*. 2013;55:93-100. doi:10.1016/j.freeradbiomed.2012.11.013

Naseem KM. The role of nitric oxide in cardiovascular diseases. *Mol Aspects Med*. 2005;26(1-2):33-65. doi:10.1016/j.mam.2004.09.003

Batista RIM, Nogueira RC, Ferreira GC, et al. Antiseptic mouthwash inhibits antihypertensive and vascular protective effects of L-arginine. *Eur J Pharmacol*. 2021;907:174314. doi:10.1016/j.ejphar.2021.174314

Burleigh MC, Sculthorpe N, Henriquez FL, Easton C. Nitrate-rich beetroot juice offsets salivary acidity following carbohydrate ingestion before and after endurance exercise in healthy male runners. *PLoS One*. 2020;15(12):e0243755. Published 2020 Dec 15. doi:10.1371/journal.pone.0243755

Rosier, B.T., Buetas, E., Moya-Gonzalvez, E.M. *et al*. Nitrate as a potential prebiotic for the oral microbiome. *Sci Rep* **10**, 12895 (2020). <https://doi.org/10.1038/s41598-020-69931-x>

Jockel-Schneider Y, Schlagenhauf U, Stölzel P, et al. Nitrate-rich diet alters the composition of the oral microbiota in periodontal recall patients. *J Periodontol*. 2021;92(11):1536-1545. doi:10.1002/JPER.20-0778

Biotics

Banakar M, Fernandes GVO, Etemad-Moghadam S, et al. The strategic role of biotics in dental caries prevention: A scoping review. *Food Sci Nutr*. 2024;12(11):8651-8674. Published 2024 Sep 26. doi:10.1002/fsn3.4473

Lin WY, Kuo YW, Chen CW, et al. Viable and Heat-Killed Probiotic Strains Improve Oral Immunity by Elevating the IgA Concentration in the Oral Mucosa. *Curr Microbiol*. 2021;78(9):3541-3549. doi:10.1007/s00284-021-02569-8

Kang, MS., Oh, JS., Lee, HC. *et al*. Inhibitory effect of *Lactobacillus reuteri* on periodontopathic and cariogenic bacteria. *J Microbiol*. **49**, 193–199 (2011). <https://doi.org/10.1007/s12275-011-0252-9>

MacDonald KW, Chanyi RM, Macklaim JM, Cadieux PA, Reid G, Burton JP. Streptococcus salivarius inhibits immune activation by periodontal disease pathogens. *BMC Oral Health*. 2021;21(1):245. Published 2021 May 7. doi:10.1186/s12903-021-01606-z

Castillo-Ruiz M, Daille LK, Machuca P, Bittner M. Antibacterial activity of a complex bacteriocin secreted by Staphylococcus epidermidis against Porphyromonas gingivalis. *Arch Oral Biol*. 2023;152:105730. doi:10.1016/j.archoralbio.2023.105730

Probiotic

Live microorganisms, mainly bacteria and yeast that confer health benefits to the host when administered in adequate amounts

Mechanism of Action: Competing with harmful bacteria for resources and producing substances that inhibit their growth

Interaction with the oral epithelium

Competitive Exclusion

Production of Antimicrobial Substances

Modulate the Immune Response

Enhance the Epithelial Barrier Function

pH Regulation

Prevention of Biofilm Formation

Jørgensen MR, Kragelund C, Jensen PØ, Keller MK, Twetman S. Probiotic Lactobacillus reuteri has antifungal effects on oral Candida species in vitro. *J Oral Microbiol*. 2017;9(1):1274582. Published 2017 Jan 18. doi:10.1080/20002297.2016.1274582

Boisen G, Prgomet Z, Enggren G, Dahl H, Mkadmi C, Davies JR. Limosilactobacillus reuteri inhibits the acid tolerance response in oral bacteria. *Biofilm*. 2023;6:100136. Published 2023 Jun 21. doi:10.1016/j.biofilm.2023.100136

VJørgensen MR, et al., Probiotic *Lactobacillus reuteri* has antifungal effects on oral *Candida* species *in vitro*. *J Oral Microbiol.* 2017;9(1):1274582. Published 2017 Jan 18. doi:10.1080/20002297.2016.1274582

Abuqwider J, et al., *Limosilactobacillus reuteri* in Health and Disease. *Microorganisms.* 2022;10(3):522. Published 2022 Feb 28. doi:10.3390/microorganisms10030522

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ProBiora, PRO-Dental, Burst, StellaLife, FLORASSIST, BioGaia, Dentalflora, Oral Care from TheraBreath, Bristle, Orasana

Streptococcus oralis KJ3, BLIS K12, *Streptococcus uberis* KJ2, BLIS M18, *Streptococcus rattus* JH145, *Lactobacillus: rhamnosus* GG, *salivarius*, *acidophilus*, *Limosilactobacillus reuteri*, *Lacticaseibacillus paracasei*, *Lactiplantibacillus plantarum*