

Prebiotics and Probiotics – Perquisite in Gut Health and Oral Health

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Abstract

Probiotics and prebiotics are increasingly being incorporated to foodstuffs with claims of health benefits. Probiotics are live microorganisms that are said to have beneficial effects on the host, whereas prebiotics are ingredients that stimulate the growth and helps in function of beneficial intestinal microorganisms. In recent times, probiotic and prebiotics have been used to assess and develop a natural balance of the microbial flora. Using prebiotics and probiotics together is said to confer synergistic effect to the host. A complete understanding of the broad ecological changes induced in the mouth by probiotics or prebiotics will be essential to assess their long-term consequences for oral health and disease (Devine & Marsh, 2009). Probiotics and prebiotics are microbiota-management tools for improving host health. They target gastrointestinal effects via the gut, although direct application to other sites such as the oral

cavity, vaginal tract and skin is being explored. In the past decade, research on the gut microbiome has rapidly accumulated and has been accompanied by increased interest in probiotics and prebiotics as a means to modulate the gut microbiota.

Keywords

Probiotics, Prebiotics, Gut Health, Oral Health , Microbiome.

Introduction

Probiotics are live non-pathogenic microorganisms administered to improve microbial balance in the host ⁽¹⁾. Probiotics together with prebiotics confer synergistic effects. The term “prebiotics” was first introduced by Gibson and Roberfroid in 1995, where they used Bifidobacterium and Lactobacillus to deliver health-promoting benefits in the host⁽²⁾. Use of microbiome therapy in homeostasis of oral cavity is a relatively new concept. In recent

times, use of probiotics is not restricted only to the gut and intestine, but also in oral cavity⁽³⁾. Thus, probiotics have been defined as “live microorganisms that, when administered in adequate amounts, confer a health benefit on the host”⁽⁴⁾. Probiotics are live bacteria and yeasts that are good for health, mainly in digestive system. The body is full of bacteria good and bad, but the probiotics is not germs that cause diseases they are often called "good or helpful" bacteria because they help to keep the gut healthy. The term probiotic came from Greek words (pro=for, bios=life). The probiotics are found in supplements and some foods, like yogurt. Doctors often suggest them to help with digestive problems (Haukiojaa, 2010).It is likely that foods and supplements that may well have exhibited prebiotic or probiotic properties have been around for centuries and used empirically in health maintenance as well as in the management of many gastrointestinal disorders. Now, this unregulated and over-the-counter market in products that claim prebiotic and probiotic properties has begun to attract the scrutiny of the scientific community. The biological effects of these substances are being investigated for their use in health or disease and many clinical studies with prebiotics and probiotics are beginning to emerge to know their impact in humans. Whether prodded by regulators or demanded by prescribers and consumers, prebiotics and probiotics are emerging from the dark and into the light of scientific scrutiny. This review will focus on the definition, biology , clinical effects, foods that are rich in probiotics and prebiotics and the future perspectives⁽⁵⁾.

History of Probiotics

Probiotics have become an important part of a healthy lifestyle for millions of people around the world. Probiotics as we know them began over one

hundred years ago when they were first discovered by Russian scientist and Nobel Prize winner, Elie Metchnikoff. While bacteria had been discovered well before this, they were not known to have potential health benefits until Metchnikoff published his work that he did at the Pasteur Institute in Paris. In 1907, as he was working in Bulgaria, Metchnikoff became curious about why certain Bulgarians lived much longer than other. He decided to focus primarily on those who surpassed the 100-year mark and began to research the common links they shared. It wasn't long before he discovered that the villagers living with the Caucasus Mountain range were drinking a fermented yogurt drink on a daily basis. His subsequent studies led him to discover that a probiotic he named *Lactobacillus bulgaricus* improved their health and helped elongate their lifespan. Starting from there he also discovered many other probiotic bacterias.Fermented milk, Fermented vegetables, Fermented bread, Fermented beer and wine have been used for yearsfrom 2000 BC.

Mechanism of Action of Probiotics

In recent times, probiotics have been used as a substitute to antibiotics to help reduce various oral conditions such as periodontitis, dental caries, and halitosis. The proposed mechanism of action can be broadly classified under direct and indirect. Direct mode of action comprises of probiotic organisms having effect on the pathogenic organisms itself. The indirect mode of action is the one with probiotic organisms modulating the host response toward the pathogens.⁽⁶⁾

Key Probiotic Organisms in History

Lactobacillus Rhamnosus GG

Reduces the intestinal permeability defects caused by exposure to cow's milk or rotavirus infection. May shorten the course of rotavirus infection causing

diarrhoea, traveller's diarrhoea and antibiotic-associated diarrhoea (7)

Lactobacillus casei

Reduces the severity and duration of diarrhoea. Stimulates the immune system of the gut, alleviates the symptoms of Crohn's disease and possesses strong antimicrobial properties (7,8,9)

Lactobacillus casei Shirota

Prevents diarrhoea caused by viruses or bacteria. It has the strongest human health efficacy with respect to management of lactose malabsorption, rotaviral diarrhoea, antibiotic-associated diarrhoea and Clostridium difficile diarrhoea. It has a preventive effect on the recurrence rate of superficial bladder cancer after surgery (9,10)

Lactobacillus acidophilus

Secretes lactic acid that lowers the pH of the intestinal content and helps to inhibit the development of invasive pathogens such as Salmonella spp. or strains of Escherichia coli. Increases antibody responses and

seroconversion rates. Lowers serum cholesterol levels (8,9,11)

Lactobacillus johnsonii

It helps to reduce density of Helicobacter pylori and inflammation as well as gastritis activity (8)

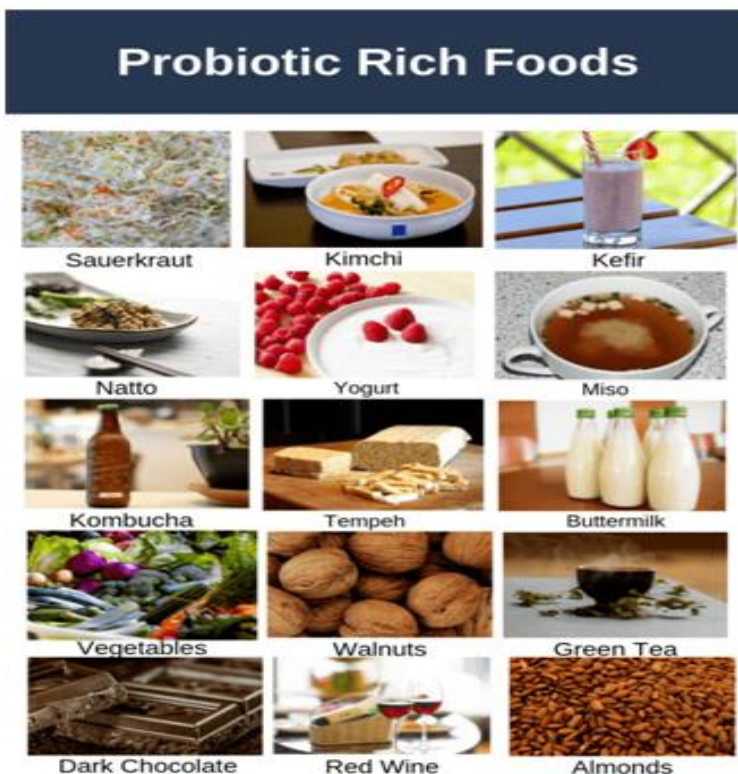
Lactobacillus plantarum

Produces short-chain fatty acids that inhibit the generation of carcinogenic products by reducing enzyme activities (8)

Foods Rich In Probiotics

Best Probiotic Food You Should Eat to Stay Healthy

Probiotic products should have the genus Bifid bacterium, Saccharomyces Boulardii, or Lactobacillus. Sometimes you may have to look for a more specific one, as each genus of bacteria includes numerous strains that give different results. This includes foods like yogurt, Kefir (a yogurt-like beverage), Kombucha (fermented black tea), Sauerkraut (refrigerated, not shelf-stable), Kimchi, Tempeh, and Miso. These foods release healthy bacteria.



1. Yogurt

Yogurt is made by culturing milk with bacteria that produce lactic acid, such as *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, although more strains can also be added. If yogurt is heat-treated, it loses its probiotic contents.

2. Buttermilk

Several different fermented dairy products are referred to as buttermilk, but the only kind that contains live probiotic cultures is the liquid that remains after butter is produced. Many types of buttermilk you would find in the grocery store do not actually contain live probiotics, so make sure to read the label closely.

3. Sourdough Bread

This kind of bread is traditionally made with fermented flour that contains healthy bacteria. However, not all brands use this method .

4. Cottage Cheese

Because cottage cheese is not aged or heated, it maintains a high amount of probiotics. Other cheeses that often contain probiotics include:

- Swiss
- Provolone
- Gouda

- Cheddar
- Edam
- Gruyère

5. Tempeh

Tempeh is a soy-based food that provides numerous health benefits. In addition to probiotics, tempeh provides an excellent source of fiber, protein, and iron.

6. Sauerkraut

Sauerkraut is fermented cabbage often served with sausage or on Reuben sandwiches. This traditional German food is a great source of fiber, B vitamins, iron, manganese, and more. Unpasteurized sauerkraut is the kind that contains all of these nutrients as well as healthy probiotics.

7. Miso Soup

Miso is a paste made by fermenting soybeans with salt and several kinds of good bacteria. The three kinds of miso are white, yellow, and red. They can be added with broth and other ingredients to make a healthy probiotic-rich soup.



Vegetable Kimchi

Staple food in Korean cuisine , it is a traditional side dish of salted and fermented vegetables , such as napa cabbage and Korean radish, made with a widely varying selection of seasonings including gochugaru, spring onions, garlic, ginger, jeotgal, etc. it is also used in variety of soups.

Prebiotics

The term was coined by Gibson and Roberfoid in 1995, where they defined prebiotics as “the substrate that is selectively utilized by host microorganisms conferring a health benefit.” (12) They are the food ingredients that are relatively not digested by host digestive system, which stimulate growth and activity of the probiotic organisms. The most commonly used prebiotics are insulin type fructans, fructo-oligosaccharide, galacto-oligosaccharide, and lactose (13)

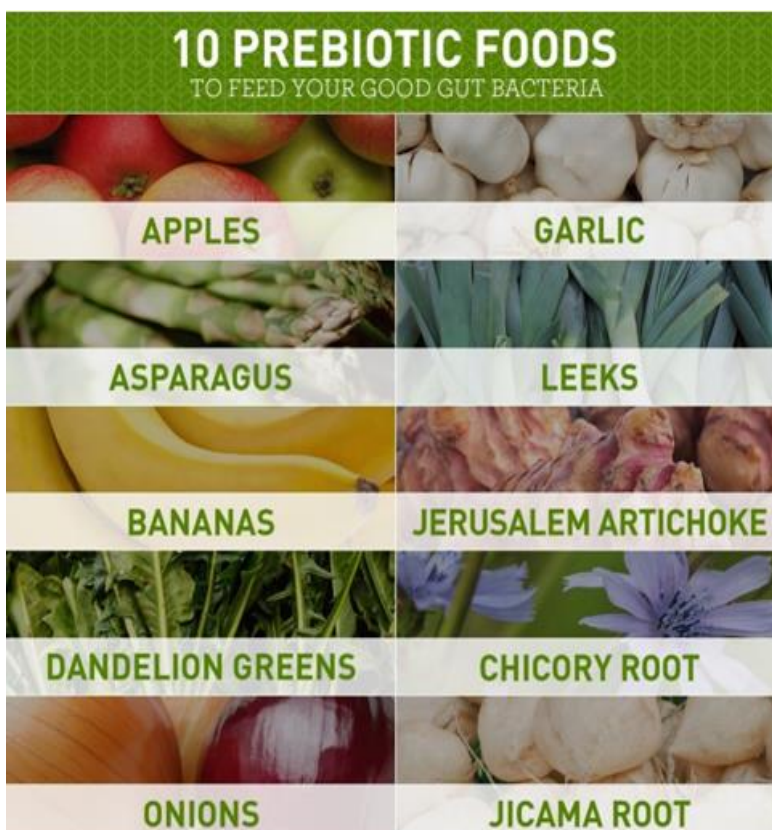
Characteristic features of ideal prebiotic

- They are neither hydrolyzed nor absorbed by mammalian enzymes or tissue.
- They selectively promote growth of certain probiotic species.
- They should be able to alter intestinal microbial flora and its activity.
- They should be able to modify systemic aspects of host defense system (14).

Mechanism of Action of Prebiotics

Fermentation is the main mechanism of action by which prebiotics are used by beneficial bacteria in the colon. Both Bifidobacteria and Lactobacillus are bacterial populations which use saccharolytic metabolism to break down substrates.

Foods Rich in Prebiotics



1. Dandelion Greens

Dandelion greens are excellent prebiotic foods and a great source of fiber and antioxidants. They can boost your digestion and immune system, reduce inflammation, and impact your cholesterol levels. The inulin fiber in dandelion greens reduces constipation, increases friendly bacteria in your gut, and boosts your immune system. Dandelion greens are also known for their anti-inflammatory, antioxidant, and anticancer effects .

Dandelion greens are delicious in salads, and can also added to green juices and smoothies. we can even make a Dandelion Root Cafe Latte using prebiotic-rich dandelion root tea.

2. Asparagus

Asparagus is one of the best prebiotic foods. Eating asparagus promotes friendly gut bacteria and can help calm inflammation. It is rich in antioxidants and has even been linked to preventing certain forms of liver cancer.

Asparagus can be enjoyed steamed, as a side dish, or as part of a salad.

3. Bananas

Bananas are high in fiber, vitamins, and minerals, and are easy to find year-round. Slightly unripe bananas have particularly powerful effects as a prebiotic food source. They can increase good gut bacteria, reduce bloating, and improve muscle relaxation.

It can be taken as a daily dose of probiotic food. It can be added to fruit salads, green smoothies, non-dairy yogurt.

4. Apples

Apples are filled with prebiotic benefits and can help rebalance your gut bacteria. In fact, the famous “apple-a-day” adage is nothing to scoff at: apples are so

rich in antioxidants, polyphenols, and pectin that eating one or more a day can improve your digestive health, boost your metabolism, decrease your LDL cholesterol, support your immune system, and impact your risk of lung and colon cancer.

They can be used as a prebiotic food for a snack, or add them to fruit salads, non-dairy yogurt, granola, green juices, smoothies, and salads.

5. Onions

Onions are versatile and nutrient-dense, rich in prebiotics, antioxidants, and flavonoids. They can strengthen the gut flora, boost the immune system, benefit the cardiovascular health, and reduces the risk of cancer.

6. Garlic

Garlic is an herb with a long tradition of medicinal use, due in part to its potent antimicrobial benefits. This prebiotic food can aid your digestion and help prevent gastrointestinal diseases. Research has shown that eating a prebiotic food such as garlic can help reduce risk of heart disease and even cancer. As with onions, it is thought that the sulfuric compounds in garlic (which give it its pungency) are behind these anti-cancer effects.

Garlic is best eaten raw, however, if you are going to cook with it, crush or chop it up first and let it sit for at least 10 minutes to activate the enzyme responsible for garlic’s amazing health benefits.

7. Leeks

Leeks are in the same family as garlic and onions (the *Allium* genus) and offer similar health benefits.

This prebiotic food source is rich in kaempferol, a flavonoid that combats oxidative stress by protecting the endothelial cells from damage caused by reactive oxygen species (ROS). Kaempferol is also

known to have anti-cancer properties. Leeks are an excellent source of vitamin K for supporting strong bones, as well as B6 for protecting heart health. The highest concentration of flavonoids in leeks is in the bulb and lower stalk.

8. Jerusalem Artichoke

Jerusalem artichoke is also known as the “earth apple”. Despite its name, this prebiotic food is not related to globe artichoke; rather it is a species of sunflower with a delicious, edible tuber.

Jerusalem artichokes are rich in potassium, thiamine, and fiber. They can improve the health of your gut and nervous system, strengthen your immune system, prevent metabolic disorders, and support muscle function.

It can be prepared similarly to potatoes by steaming, boiling, baking, or sauteing them or it can be eaten raw.

9. Chicory Root

Chicory root is a fantastic prebiotic food source that

stimulates the growth of “good” bacteria while suppressing “bad” bacteria. In addition, chicory can improve your digestion, relieve constipation, prevent the early onset of diabetes, and aid in detoxification by supporting liver function.




Chicory root has a distinct, coffee-like flavor. When prepared as a tea, it is a wonderful alternative to coffee that can be particularly helpful for those trying to quit caffeine.

10. Jicama Root

Jicama root is a Mexican tuber that’s crunchy, light, and low in calories. Many people describe the taste as a combination between a potato and an apple.

Jicama is rich in prebiotic fiber, vitamin C, and amino acids. It is great for your digestion, blood sugar levels, and immune system.

Jicama root can be enjoyed raw, in salads, or make jicama rice..

Probiotic	Prebiotic	Symbiotic
<ul style="list-style-type: none"> Live micro organisms when administered serves beneficial effects to the host Acts on any part of the body. Non pathogenic, non toxic More fragile, vulnerable to heat, stomach acid, killed over time. Fight the harmful bacterial species in the gut, maintain normal flora balance, supports GI and systemic immunity <p>Indications: Irritable bowel syndrome Dysphagia, intestinal infections, prevent or reduce the severity of cold and flu and aids digestion, Cancer prevention</p> <p>Available forms: as food, capsules, powder sachets, chewing gums</p> <p>Main organisms used Lactobacillus Lactococcus Propionibacterium Bifidobacterium Bulgarius Strep.thermophilus, fecalis</p> <p>Side effects: possibility of sepsis in immunocompromised patients</p>  <p>Brand names • Culturelle • Bifidac • Amway Nutrilite Fiber</p>	<ul style="list-style-type: none"> Usually carbohydrate non digestible food ingredient with, non living microorganisms stimulating the available microbes in colon Acts primarily on colon but broader effects also Withstands heat, acid, cold and time Nourishes the bacteria in the gut and may support and modulate immune function <p>Indications: Aids in digestions, preventive treatment of irritable bowel diseases and colorectal cancer</p> <p>Available form: mainly as food, powder sachets</p> <p>Types: 1. Fructans- Inulin, fructo oligosaccharides 2. Galacto-oligosaccharides 3. Starch and glucose derived 4. Other oligosaccharides</p> <p>Side effects: Increase in fermentation can lead to gas formation, bloating</p> <p>Prebiotic Killers <ul style="list-style-type: none"> Consuming probiotics with tea, caffeine or aerated drinks Overuse of prescription antibiotics Alcohol (except red wine) Smoking Sugar GMO foods Lack of exercise Emotional stress Over-sanitation Poor sleep habits Unhealthy fats Tap water with chlorine and fluoride </p> 	<p>Combination of Probiotics and prebiotics (microbiome therapy)</p> 

Health Benefits of Prebiotics and Probiotics

The most important and documented beneficial effects of probiotics include the prevention of diarrhea, constipation, changes in bile salt conjugation, enhancement of anti-bacterial activity, anti-inflammatory. Furthermore, they also contribute to the synthesis of nutrients and improve their bioavailability; some probiotics are known to exert anti-oxidative activity in the form of intact cells or lysates. Probiotics have also demonstrated their inherent effects in alleviating symptoms of allergy, cancer, AIDS, respiratory and urinary tract infections. There are stray reports on their beneficial effects on aging, fatigue, autism, osteoporosis, obesity and type 2 diabetes (15).

Diarrhea

Diarrhea is defined by the World Health Organization as three or more loose or watery stools during 24-hour period. In the last 2 decades, several investigations on probiotic microorganisms by *in vitro* studies, animal experiments and appropriate well-designed clinical studies have validated the positive effects of probiotic consumption in arresting diarrhea of different types (16).

Acute Infantile Diarrhea

Acute infantile diarrhea caused by rotaviruses is most studied gastrointestinal condition and rapid oral rehydration is the primary treatment. Probiotics have been found to be useful as adjunct to rehydration therapy (17).

Antibiotic Associated Diarrhea

Disturbance/destruction of the indigenous microflora caused by antibiotic treatments often leads to diarrhea. The main mechanism by which antibiotics cause diarrhea is through impaired resistance to pathogens as a result of disruption of the gut microbial flora and subsequent alterations in the metabolism of

carbohydrates, short-chain fatty acids, and bile acids (18). Probiotics including various bacterial species like *L. acidophilus*, *L. rhamnosus GG*, *L. delbrückii*, *L. fermentum* etc. and the yeast *S. boulardii* are effective in reducing the incidence of antibiotic-induced diarrhea (19).

Irritable Bowel Syndrome (IBS)

IBS is one of the most common functional gastrointestinal disorders and is a chronic condition characterized by recurrent bouts of abdominal discomfort and pain, bloating and a changeable bowel habit with an absence of any overt mucosal abnormality and flatulence.

Probiotic strains like *Lactobacillus plantarum* decreased flatulence and relieved abdominal bloating (20). Reduction in pain was observed with *L. rhamnosusGG* (21). Different studies in adults showed that *B. infantis*, *L. rhamnosus GG* and mixture of different probiotics such as *L. rhamnosusGG*, *L. rhamnosus LC705*, *B. breve Bb99* and *Propionibacterium freudenreichiiJS* were found to be proved effective in IBS treatment (22,23).

Inflammatory Bowel Disorder: (IBD)

IBD is chronic, relapsing, multi-factorial disorder causing inflammation of the gastro-intestinal tract that causes severe watery and bloody diarrhea accompanied by abdominal pain. IBD affects both -the colon and small intestine and includes Ulcerative colitis (UC), Crohn's Disease (CD) and pouchitis (24). *Lactobacillus casei* and *Bifidobacterium bifidum* has shown promising results for UC (25).

Several studies on both acute and chronic intestinal inflammation suggest that probiotics, prebiotics and/or synbiotics may be helpful in the management of inflammatory bowel disorder (26).

Lactose Intolerance

Lactose intolerance is most common type of carbohydrate intolerance and attributed to lack of digestion of lactose due to low levels of β galactosidase enzyme. Symptoms include abdominal distress like diarrhea, bloating, abdominal pain and flatulence.

With probiotics such as *Lactobacillus bulgaricus* and *Streptococcus thermophiles*. It is also observed that consumption of milk containing *Bifidobacterium longum* and *L. acidophilus* cause significantly less hydrogen production and flatulence. The combination of *Lactobacillus caseishirota* and *Bifidobacterium breve* Yakult has shown better effect and improved the symptoms of lactose intolerance significantly (27).

Probiotics and Oral Health

Probiotics and Dental Caries

Caries is an infectious microbial disease of oral cavity caused by fermentation of carbohydrates by bacteria resulting in dissolution of the mineral content of the tooth structure. The main organism responsible is *S. mutans*(28)

L. rhamnosus GG strain, *L. reuteri*, and *Bifidobacterium lactis* BB-12 strain when used as probiotics have shown significant reduction in the number of *S. mutans*. They potentially deter the microbiota of dental plaque and reduce the adhesion of bacteria to the tooth surface, resulting in reduced incidence of dental caries. When multispecies or multistrains of probiotic organisms are used, there is a considerable decline in the cariogenic bacteria(29). Similarly, *L. rhamnosus* 1b21 strain, when used in milk along with fluoride, produces the same result(30).

Probiotics and Halitosis

Halitosis is the general term used to describe any disagreeable odor of expired air, regardless of its origin.³⁷ It is an unpleasant odor most commonly caused by *Fusobacterium nucleatum*, *P. gingivalis*, *P. intermedia*, and *T. denticola*. *L. salivarius* WB21 strain when administered orally as tablet, thrice a day, showed a significant decrease in organoleptic (31). *W. cibaria* when used as a probiotic agent demonstrated a reduction in H_2 O_2 production, due to inhibition of *F. nucleatum* (32). *Streptococcus salivarius* (K12 strain), one of the pioneer probiotic strain, secretes bacteriocin, which when consumed as lozenges helps reduce *Solobacterium moorei*, thereby reducing oral mal odor(33). *L. reuterin* has also been beneficial in promoting oral health and reducing oral mal odor (34).

Role of Probiotics in Oral Cancer

The anticancer effects of probiotics were long recognized but evidence in literature is minimal. Evidence is cropping up that probiotics can interfere at various stages of cancer process, more so by interference with chromosomal and DNA damage. However, more research is required to develop specific regulations on their consumption (de Roos & Katan, 2000; Salminen, et al. 2002).

Conclusion

The goal of this review was to find out the existing literature regarding the use of probiotics in general and oral health. Probiotics and prebiotics are useful in maintaining normal homeostasis of the body. With an increasing threat of microorganisms developing resistance to the known antibiotics, probiotics have emerged as an improved and innovative solution to the above-stated problem. Probiotics are way ahead of their conventional counter products with an added advantage of minimal side effects. "Designer probiotics," a relatively new concept of genetically

modified microorganisms which target a specific pathogen, can be utilized as a novel tool to act against the severe general and oral diseases. Successful use of probiotics in dentistry can pave a way to advanced treatment options and therapy modules to augment the oral health in general. We encourage more research on probiotics and prebiotics to serve the people of developing countries, who might stand to benefit most from these interventions.

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