

REVIEW ARTICLE

**BACTERIOTHERAPEUTIC APPROACH OF ORAL DISEASES -
A REVIEW OF LITERATURE****Milling Tania S.D.* , Job Jacob Anison****

* Senior Lecturer, Department of Orthodontics and Dentofacial Orthopaedics, Rajas Dental College & Hospital, Tirunelveli, Tamil Nadu.

** Reader, Department of Orthodontics and Dentofacial Orthopaedics, Tagore Dental College & Hospital, Rathinamangalam, Chennai, Tamil Nadu.

Corresponding Author: Dr. Job Jacob Anison

ABSTRACT

According to WHO Depressive disorders will become the second leading cause of disability worldwide after heart Bacteriotherapy with the concept of using good bacterial strain to replace the pathogenic ones emerged as a fascinating field with the increasing incidence of antibiotic resistance. Bacteriotherapy synonymous to probiotics has been in practice for several years in general health. Interest has been drawn towards oral health in the recent years. The studies conducted on oral health suggest that probiotics could be a viable option in preventing and treating the common oral infections like caries, periodontitis and halitosis. This article updates the available data on the potential benefits of probiotics for oral health.

Key words: Bacteriotherapy, Probiotics, pathogenic

INTRODUCTION

Bacteriotherapy using bacteria or bacterial products to combat bacterial diseases is a unique concept slowly progressing in the field dominated by antibiotics. This alternative therapy commonly used for recurrent diseases relies on the concept of using harmless bacteria to displace pathogenic organisms causing diseases. Probiotics as one of the bacteriotherapeutic agents have been widely associated with gut health and most clinical interest has been focused on their use for prevention or treatment of Gastro-intestinal infections and diseases. As the bacterial resistance to antibiotics is emerging these days, it is wise to consider the unique concept of probiotic therapy in oral health. Researchers are now investigating the use of probiotics for oral health. Although only a few studies have been conducted so far, the results of these studies have identified the positive role of probiotics in preventing and treating oral infections like dental caries, periodontal diseases and halitosis. This article reviews the recent data about probiotics in terms of its application in dentistry and the database used for this review search was PubMed or MEDLINE.

EVOLUTION:

This concept dates back to the beginning of 20th century when the Russian Nobel laureate Eli Metchnikoff¹ came up with the idea of modifying gut flora to replace harmful microbes by other microbes. The longevity of this theory was doubted & disputed by many at that stage. The term Probiotics was first used by Lilly and Stillwell² in 1965. In 2001, FAO/WHO defined Probiotics

as *live microorganisms which when administered in adequate amounts confer a health benefit on the host*³.

MODUS OPERANDI OF PROBIOTICS:

Different mechanisms of action of probiotics have been proposed like^{4, 5, 6, 7}

- a. Competitive blocking of the adhesion sites at epithelial surfaces.
- b. Secretion of various antimicrobial substances such as organic acids, H₂O₂, Bacteriocin.
- c. Immune modulation - modifying the surrounding environment by modulating the pH and/or the oxidation–reduction potential, which may compromise the ability of pathogens to become established.
- d. Stimulation of immunoglobulin A production.
- e. Down regulation of inflammatory response.

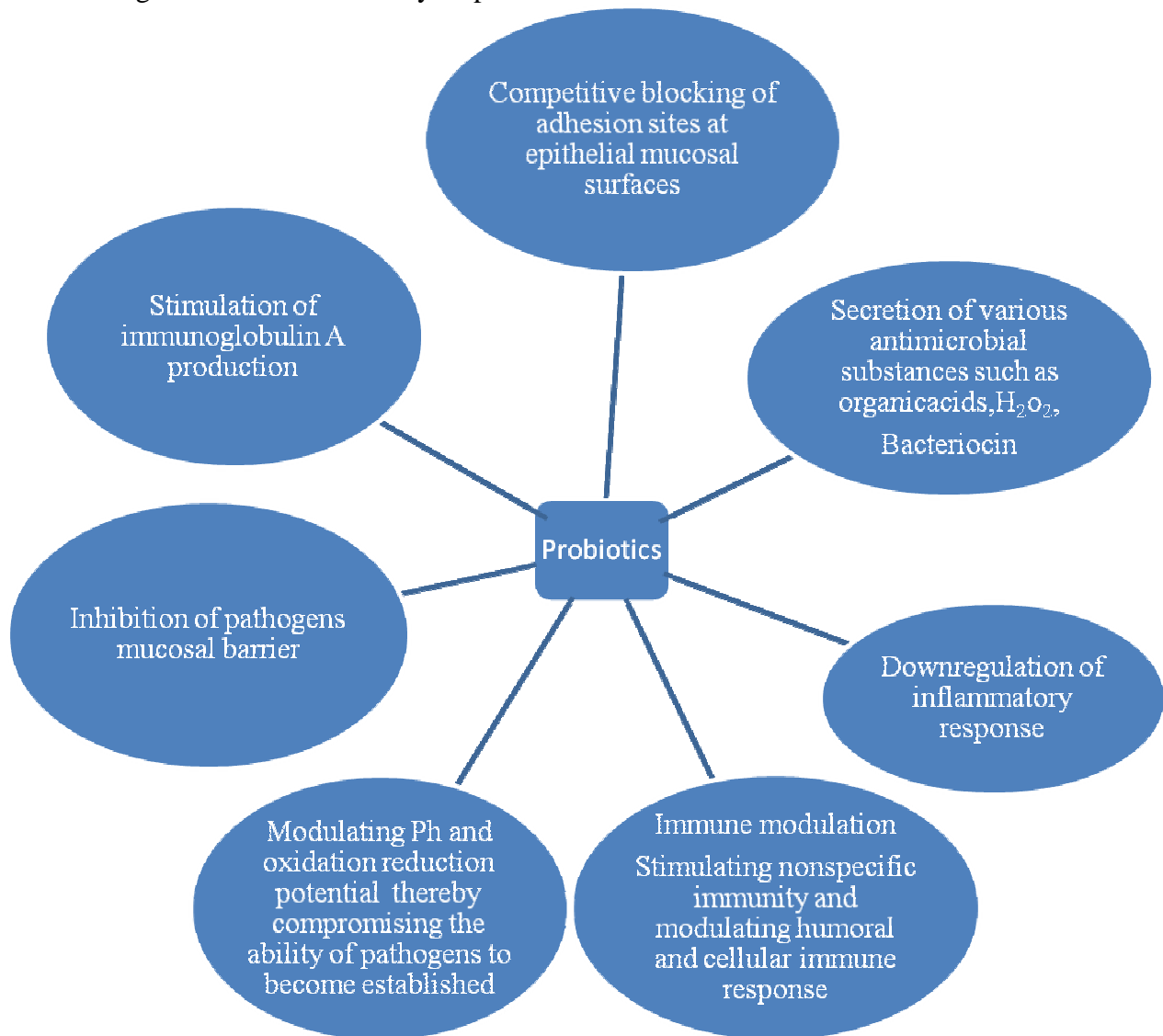


Figure 1: Probiotics in general health

The effects of probiotics in general health have been documented in several studies^{1, 8}. Some of the applications to mention are:

Gastro intestinal problems:

Since its introduction, Probiotics are widely recommended in Gastroenterology due to its multifaceted role like:

1. Reduction of the concentration of cancer-promoting enzymes in the gut.
2. Prevention and alleviation of unspecific complaints of the gastrointestinal tracts in healthy people.
3. In patients suffering from constipation and irritable bowel syndrome, probiotics normalizes the stool consistency and facilitates its smooth passage.
4. Probiotics are used in antibiotic associated diarrhoea and in reduction of the complaints due to lactose intolerance.
5. Its positive role has been appreciated in helicobacter pylori-infection of the gut.

Respiratory tract infections:

Probiotics also used in prevention of respiratory tract infections like common cold, influenza, allergies and atopic diseases in infants.

Urological complaints:

Studies have proved the positive role of bacteriotherapy in pediatric urology like decreasing the risk of infective, inflammatory, carcinogenic and other stone diseases.

The applications of probiotics in the field of medicine are wide, extending into almost all its branches, and Dentistry is not an exception.

PROBIOTICS IN DENTISTRY

The oral cavity is the harbor for a wide range of nearly 600 healthy microorganisms with a balance and harmony existing between them. Some of them are *Lactobacillus acidophilus*, *Lactobacillus casei*, *Lactobacillus rhamnosus*, *Lactobacillus salivarius* and *Lactobacillus plantarum*. When there is an alteration in this oral ecological balance because of the prevalence of pathogenic organism, it results in diseases like dental caries, periodontitis and halitosis. By administering healthy bacteria which can compete with the pathological ones, the normal oral ecological balance can be restored thereby preventing and alleviating the problems.

Studies conducted have revealed the success of bacteriotherapy in the prevention and alleviation of the three most common problems of oral cavity like dental caries, periodontitis and bad breath (halitosis).

An essential condition for a microorganism to represent a probiotic of interest for oral health is its capacity to adhere to and colonize various surfaces of the oral cavity^{9, 10}. The most common oral probiotic strains belong to the genera *Lactobacillus* and *Bifidobacterium*.

The Various probiotic strains isolated from *Lactobacillus* include *L. acidophilus*, *L. reuteri*, *L. casei*, *L. rhamnosus*, *L. johnsonii*, and *L. gasseri*.^{11,12,13}

The Various probiotic strains isolated from *Bifidobacterium* include *B. longum*, and *B. infantis*, *B. bifidum*.

The survival of various probiotics used by the dairy industry in saliva and their adherence to oral surfaces was assessed by Haukioja et al¹⁴ and found that all of the strains tested survived well in saliva, but with a varied adherence capacity to the surface of teeth and oral mucosa. Species in the genus *Lactobacillus* had an adherence capacity superior to that of the *Bifidobacterium* species.

Probiotics and Dental Caries

The role of Probiotics in reducing the level of *Streptococcus mutans*, the tributary of dental caries has been verified in several studies. Studies conducted with *L. rhamnosus*, *L. reuteri* have proved their anti-cariogenicity by interacting with *Streptococcus mutans* (*S. mutans*) and reducing its number.

Several species of Lactobacilli are being tried as a probiotic in the prevention of dental caries. *Lactobacillus rhamnosus*-fermented milk was found to reduce dental caries in children¹⁵. Similar effects were ascertained when yogurt containing *Lactobacillus reuteri*¹⁶ was consumed, with 80% reduction of *S. mutans* in saliva. Similarly *Lactobacillus reuteri* was used in another study evaluating the efficacy of probiotic chewing gums and xylitol chewing gums on patients¹⁷. It was found that both the agents reduced the *streptococcus mutans* levels. But on combining both the agents, no synergic effect was observed.

These positive results counsel a potential beneficial application of probiotics as a caries prophylactic agent. In future, probiotic implementation can even challenge the invasive operative intervention in operative dentistry¹⁸.

Probiotics and Periodontal Disease

Periodontal pathogens like *Porphyromonas gingivalis*, *Prevotella intermedia* and *A. Actinomycetemcomitans* have been checked by various probiotic strains like *L. reuteri*, *L. brevis* (CD2), *L. caseishirota*, *L. salivarius* WB21, and *Bacillus subtilis*. The *L. reuteri* and *L. brevis* strains were used in several in-vivo studies.

In a parallel, double-blind randomized study conducted using *L. reuteri* as the probiotic strain, significant improvement of the clinical parameters were seen after the consumption of chewing gum containing *L. reuteri*¹⁹.

Kang et al²⁰ in a placebo-controlled study found a 20% reduction in plaque scores when *Weissella cibaria* CMS containing rinse was used, suggesting its role in inhibiting plaque formation.

Ishikawa et al²¹ conducted a study using tablets containing *L. salivarius* and noted a significant reduction of black pigmented anaerobic rods.

Use of tablets containing *L. salivarius* WB21 has been shown to decrease gingival pocket depth, particularly in high-risk groups such as smokers, and also affect the number of periodontal pathogens in plaque²².

A notable role of probiotic in periodontal bone destruction has been enunciated in an invitro study by Nara et al²³. This study conducted using *L. helveticus* demonstrated the release of short peptide stimulating osteoblast, thus promoting bone formation.

Although promising results have been observed in various periodontal diseases, further studies are needed in future for its successive application.

Probiotics and halitosis

Oral halitosis i.e. bad breath regularly affects about one in four adults and frequently is caused by anaerobic bacteria that degrade salivary and food proteins to generate amino acids, producing volatile sulfur compounds (VSCs). Halitosis is considered to be an aesthetic problem, with several local and systemic causative factors.

Physiologic halitosis results from an imbalance in the microbiota of the oral cavity, in contrary to "pathologic" halitosis where patients usually present with organic lesion like caries or periodontitis.

In a recent study conducted with tablets containing *L. salivarius*, it's proved that both the patients with physiologic and pathologic halitosis equally benefited from a two-week therapy. Additionally a significant reduction in the level of the volatile compounds and gingival bleeding

on probing from periodontal pockets was found. *Lactobacillus salivarius* TI2711 bacteria were also able to scale back the count of the bacteroides, the bacteria that is responsible for the production of the volatile sulphur compounds causing halitosis²⁴. A study by Kang et al.²⁵ reported that gargling with a solution containing various strains of *Weissella Cibaria* (*W. Cibaria*) has ability to decrease the production of volatile sulphur compounds (hydrogen sulphide and methanethiol) by *Fusobacterium nucleatum* (*F. Nucleatum*). Recently probiotic products are marketed for halitosis, although their efficacy demands further clinical studies and research.

Probiotics and Oral Candidosis

Candidiasis or moniliasis can occur when the immune system is suppressed or altered by certain diseases or prolonged medications like corticosteroids or broad spectrum antibiotics. Prolonged medications can alter the normal oral ecology thereby clearing the normal bacteria that keeps the candida in check resulting in candidiasis. Healthy bacterial species when administered can restore the normal oral ecology checking the growth of candida. Recently, probiotic strains like *lactobacillus acidophilus* and *lactobacillus rhamnosus* are tested in few studies for its efficacy against candida.

In a prospective double-blind randomized study conducted by Kumar et al²⁶, a significant reduction in the number of candidal colonies were observed in patients receiving broad spectrum antibiotics following the administration of probiotic strains like *lactobacillus acidophilus*, *lactobacillus rhamnosus*.

In another randomized controlled trial conducted on elderly subjects by Hatakka et al²⁷, a significant reduction in the prevalence of oral candid was seen following administration of cheese containing probiotic *L. rhammnosus* GG for a period of 16 weeks.

A laboratory study conducted on candida infected mice fed with *L. acidophilus* revealed a similar positive finding²⁸.

These findings offer a new strategy for controlling oral yeast infections in medically compromised elderly subjects. In future, probiotics can be regularly supplemented in critically ill patients receiving broad spectrum antibiotics to reduce the gut candidal colonization and candiduria. Probiotics seem to be a natural therapeutic and prophylactic option in these patients.

Probiotics and White Spot Lesions

White spot lesions are caused by *streptococcus mutans* and they common scars found during and after orthodontic treatment. The health promoting bacteria can address the imbalance in the oral biofilm by competitively inhibiting the pathogens and shifting the oral mileau to a higher ph thereby reversing the demineralization. Recently in a study by Jose et al²⁹, the consumption of probiotic curd and twice daily brushing with a probiotic tooth paste significantly reduced the streptococcus mutans levels in the plaque around the brackets in orthodontic patients. The proven effect of probiotic strains in combating with streptococcus mutans can be utilized in controlling white spot lesions. The studies on the control of white spot lesions by probiotics are still in its primitive stage. Further studies are needed for a promising result.

DISCUSSION:

Bacteriotherapy in the form of probiotics has opened new vistas in the field dominated by antibiotics. Providing healthy bacteria to combat the pathogenic organisms is a valuable and viable option in problems arising due to antibiotic resistance. This concept throws new light on the connections between diet and health. Probiotics initially used in gastroenterology for promoting the gut health, has slowly found way its way in the oral cavity, the entrance of the GI tract.

The benefits of probiotics in oral health have been under research recently. Several studies have also proven its efficacy in combating the common oral diseases like dental caries, periodontitis and halitosis. Further double-blind, randomized, placebo-controlled trials are needed before it can be used as regular diet supplementation of these beneficial strains as a prophylactic measure.

However, the safety of probiotics needs to be weighed before its administration. The probiotic strains should not be pathogenic and should not transfer the antibiotic resistance genes. With the enormous supplementation of probiotics in different food items, it's quite logical to think of the development of bacteremia.

But it is a rare entity. Bacteremia usually develops in patients with severe debilitating diseases where the immune system is weakened. Further the incidence of bacteremia is unsubstantiated in literature³⁰. Nevertheless, careful monitoring is needed with this regard in the future.

Genetically modified microbial strains³¹ are expected to add a new dimension to the concept of bacteriotherapy in the future. The modified strains are expected to reduce the pathogenicity of the potential pathogenic organisms and enhance the beneficial characters of a good strain.

Further newer advancements in the field of probiotics can be expected in the future.

CONCLUSION

Probiotics in oral health has emerged as an area of clinical interest. This review article focuses on the different studies of probiotics conducted on a dental perspective. Though, several studies have shown promising results, further Randomized controlled trials are needed for its successful implementation in the future as a therapeutic and prophylactic agent.

REFERENCES:

1. Parvez S, Malik KA, Ah Kang S, Kim HY. Probiotics and their fermented food products are beneficial for health. *J Appl Microbiol.* 2006;100(6):1171-85.
2. Lilly DM, Stillwell RH. Probiotics: growth promoting factors produced by microorganisms. *Science* 1965;147:747-748.
3. Food and Health Agricultural Organization of the United Nations and World Health Organization. Guidelines for the evaluation of probiotics in food. Joint FAO/WHO Working Group Report on Drafting Guidelines for the Evaluation of Probiotics in Food. 2002.

4. Meurman JH. Probiotics: do they have a role in oral medicine and dentistry? *Eur J Oral Sci.* 2005;113(3):188-96.
5. Niel CWV. Probiotics: not just for treatment anymore. *Pediatrics.*2005;115(1):174-7.
6. Saavedra JM, Abi-Hanna A, Moore N, Yolken RH. Long-term consumption of infant formulas containing live probiotic bacteria: tolerance and safety. *Am J Clin Nutr.* 2004;79(2):261-7.
7. Gueimonde M, Salminen S. New methods for selecting and evaluating probiotics. *Dig Liver Dis.* 2006; 38 (Suppl 2):242-7.
8. de Vrese M, Schrezenmeir J. Probiotics, prebiotics, and synbiotics. *Adv Biochem Eng Biotechnol.* 2008; 111:1-66.
9. Meurman JH, Stamatova I. Probiotics: contributions to oral health. *Oral Dis.* 2007;13(5):443-51.
10. Comelli EM, Guggenheim B, Stingle F, Neeser JR. Selection of dairy bacterial strains as probiotics for oral health. *Eur J Oral Sci.* 2002;110(3):218-24.
11. Teanpaisan R, Dahlen G. Use of polymerase chain reaction techniques and sodium dodecyl sulphatepolyacrylamide gel electrophoresis for differentiation of oral *Lactobacillus* species. *Oral Microbiol Immunol.* 2006;21:79–83.
12. Colloca ME, Ahumada MC, Lopez ME, Nader-Macias ME. Surface properties of lactobacilli isolated from healthy subjects. *Oral Dis.* 2000;6:227–233.
13. Koll-Klais P, Mandar R, Leibur E, Marcotte H, Hammarstrom L, Mikelsaar M. Oral lactobacilli in chronic periodontitis and periodontal health: species composition and antimicrobial activity. *Oral Microbiol Immunol.* 2005;20:354–361.
14. Haukioja A, Yli-Knuutila H, Loimaranta V, Kari K, Ouwehand AC, Meurman JH, et al. Oral adhesion and survival of probiotic and other lactobacilli and bifidobacteria in vitro. *Oral Microbiol Immunol.* 2006;21(5):326-32.
15. Näse L, Hatakka K, Savilahti E, Saxelin M, Pönkä A, Poussa T, et al. Effect of long-term consumption of a probiotic bacterium, *Lactobacillus rhamnosus* GG, in milk on dental caries and caries risk in children. *Caries Res.* 2001;35(6):412-20.
16. Nikawa H, Makihira S, Fukushima H, Nishimura H, Ozaki K, Darmawan S, et al. *Lactobacillus reuteri* in bovine milk fermented decreases the oral carriage of mutans streptococci. *Int J Food Microbiol.* 2004;95(2):219-23.
17. Caglar E, Kavaloglu SC, Kuscü OO, Sandalli N, Holgerson PL, Twetman S. Effect of chewing gums containing xylitol or probiotic bacteria on salivary mutans streptococci and lactobacilli. *Clin Oral Investig.* 2007;11(4):425-9.
18. Anderson MH, Shi W. A probiotic approach to caries management. *Pediatr Dent.* 2006;28:151–153.
19. Krasse P, Carlsson B, Dahl C, Paulsson A, Nilsson A, Sinkiewicz G. Decreased gum bleeding and reduced gingivitis by the probiotic *Lactobacillus reuteri*. *Swed Dent J.* 2006;30(2):55-60.
20. Kang MS, Na HS, Oh LS. Coaggregation ability of *Weissella cibaria* isolates with *Fusobacterium nucleatum* and their adhesiveness to epithelial cells. *FEMS Microbiol Lett.* 2005;253:323–329.
21. Ishikawa H., Aiba Y., Nakanishi M., Ohhashi Y., Koga Y. Suppression of periodontal pathogenic bacteria in the saliva of humans by the administration of *Lactobacillus salivarius* TI 2711. *J Jap Soc Periodontol.* 2003;45:105–112.
22. Shimauchi H, Mayanagi G, Nakaya S et al. Improvement of periodontal condition by probiotics with *Lactobacillus salivarius* WB21: a randomized, double-blind, placebocontrolled study. *J Clin Periodontol.* 2008;35:897–905.

23. Narva M, Halleen J, Väänänen K, Korpela R. Effects of *Lactobacillus helveticus* fermented milk on bone cells in vitro. *Life Sci.* 2004;75(14):1727-34.
24. Burton JP, Chilcott CN, Moore CJ, Speiser G, Tagg JR. A preliminary study of the effect of probiotic *Streptococcus salivarius* K12 on oral malodour parameters. *J Appl Microbiol.* 2006;100(4):754-64.
25. Kang MS, Kim BG, Chung J, Lee HC, Oh JS. Inhibitory effect of *Weissella cibaria* isolates on the production of volatile sulphur compounds. *J Clin Periodontol.* 2006;33(3):226-32.
26. S Kumar, A Bansal, A Chakrabarti Evaluation of Efficacy of Probiotics in Prevention of Candida Colonization in a PICU—A Randomized Controlled Trial. *Critical care medicine*, 2013
27. Hatakka K, Ahola AJ, Yli-Knuuttila H, Richardson M, Poussa T, Meurman JK. Probiotics reduce the prevalence of oral *Candida* in the elderly – a randomized controlled trial. *J Dent Res.* 2007;86:125–130.
28. Elahi S, Pang G, Clancy A, Clancy R. Enhanced clearance of *Candida albicans* from the oral cavities of mice following oral administration of *Lactobacillus acidophilus*. *Clin Exp Immunol.* 2005;141:29–36.
29. Jose JE, Padmanabhan S, Chitharanjan AB. Systemic consumption of probiotic curd and use of probiotic toothpaste to reduce *Streptococcus mutans* in plaque around orthodontic brackets. *Am J Orthod Dentofacial Orthop* 2013 Jul; 144(1):67-72.
30. Husni RN, Gordon SM, Washington JA, Longworth DL. *Lactobacillus* bacteremia and endocarditis: review of 45 cases. *Clin Infect Dis.* 1997; 25: 1048-55.
31. Sareen M, Roy S, Singh SK, Gupta A. A review on probiotics and their implications in dentistry. *Journal of dento facial sciences*, 2012; 1(2): 7-10