

Probiotics and Oral Malodor

Nitish Bhat¹, Nandini Bhardwaj², Abhiney Puri³, Rajat Nangia⁴

ABSTRACT

The efficacy of probiotics or the viable bacteria specifically in the oral cavity with proven health benefits acts as a natural approach against the naturally developing microbiome imbalance and is enormously popular worldwide. To put a stop to oral diseases, probiotics bring to us an imperative concept of biological changes in microbial flora. Various clinical studies reveal the reduction in the concentration of bacteria causing dental caries, halitosis, and periodontitis. The prevention and control of oral malodor or halitosis is spotlighted as it unswervingly affects the communal life in polygenic unfavorable ways. This paper evaluates the present acquaintance, etiology, verdict, and promising management approaches for oral malodor with probiotics.

Keywords: Bacterial strains, Colonization, Oral malodor, Probiotics, Volatile sulfur compounds.

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INTRODUCTION

Genetics, diet, stress, and disease influence the emission of variety of volatile and nonvolatile molecules by humans. A complaint analogous to body odor¹ called oral malodor, also called halitosis or bad breath (fedor ex ore)² describes any disagreeable odor in the breath.¹ The oral odors include ozostomia, stomatodysoxia, halitosis, and fetor oris/ex ore.³ According to Tonzetich,⁴ bad breaths prevails as a severe chronic problem in about 50% of population. Personal discomfort along with social embarrassment signals its consequence as presence of disease leading to emotional distress.²

Oral Malodor

Various terminologies used the following: halitosis, bad breath, fetor ex ore.² Definition: bad or unpleasant smells from the oral cavity or outside the oral cavity.⁴ Latin meaning: "Halitus," breath and "Osis," pathological process in Greek.⁴

Gram negative anaerobes present on the dorsum of the tongue and some residing in periodontal pockets mainly contributes to ascription of bad breath in the oral cavity.¹ Bacterial putrefaction results in some chemical end products known as volatile sulfur compounds (VSCs). Cysteine, cystine, and methionine are the sulfur amino acids on which bacteria act and produce offensive odor 20 and compounds like VSCs such as hydrogen sulfide (H₂S), methyl mercaptan (CH₃SH), and dimethyl sulfide (CH₃SCH₃) as metabolites.⁵ Implications of some nonsulfur containing compounds such as cadaverine, putrescine, indole, and skatole have also been found.⁶

A disease with several disorders including metabolic, respiratory⁷ consumption of foods like spices, garlic, and consumption of alcohol and tobacco chewing 60¹ needs to be improved. It has been shown that the use of probiotics in, the suppression of oral malodor serves as an adjunct for its prevention and treatment.² According to United Nation's Food and Agricultural Organization (FAO) and the World Health Organization (WHO): defined probiotics as living microorganisms, principally bacteria that are safe for human consumption, and when ingested in sufficient quantities, it has beneficial effects on human health, beyond basic nutrition.⁸

Colonization of probiotics bacterial strains, i.e., bacteriotherapy improves this condition by replacement of bacteria in halitosis with

¹Department of Oral Pathology, Indira Gandhi Government Dental College, Amphalla, Jammu and Kashmir, India

²⁻⁴Department of Oral and Maxillofacial Pathology, Microbiology and Forensic Odontology, Himachal Institute of Dental Sciences, Sirmour, Himachal Pradesh, India

Corresponding Author: Nandini Bhardwaj, Department of Oral and Maxillofacial Pathology, Microbiology and Forensic Odontology, Himachal Institute of Dental Sciences, Sirmour, Himachal Pradesh, India, Phone: +91 9816173522, e-mail: nandinibhardwaj313@gmail.com

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the colonization of probiotics bacterial strains from humans, i.e., bacteriotherapy improves this condition.¹

DISCUSSION

Halitosis proves to be among the 100 most common causes of distress with 50% prevalence according to a study in The Netherlands.⁴ Many etiological factors contribute to the attribution of bad breath from the oral cavity including local and systemic disorders.² *Solobacterium moorei* is the bacterium associated with halitosis, but in some cases of halitosis, specific bacterial species are associated with peptides such as glutathione, proteins, and salivary mucins.⁹ Etiological compartment of oral malodor can be grouped into intrinsic/intraoral sources and extrinsic/extraoral sources. Poor oral hygiene, plaque-related gingival and periodontal diseases such as gingivitis, periodontitis, and systemic diseases such as infectious, cutaneous, gastrointestinal diseases, and reduced salivary flow, etc., are the factors predisposing to intraoral or intrinsic halitosis (Table 1).^{1,10,11}

Oral factors contribute to 90% along with 10% systemic factors.² Conditions which do not affect the oral cavity primarily, i.e., extraoral causes seem to be in less association with halitosis.¹ Extraoral sources include polyps, postnasal drips, sinusitis, and in women during ovulation, menopause, etc. Bronchial and lung

infections along with biochemical disorders can also contribute to bad breath.² Microbial etiology of halitosis can also be explained on the basis of two theories. First being the specific theory which states that only few specific single species causes malodor. Nonspecific theory works on the principle of biotransformation of substrates into volatile compounds by many bacterial species mostly anaerobes.¹ Halitosis is grouped into delusional (pseudohalitosis and halitophobia) and genuine halitosis. Genuine halitosis is further divided into physiologic and pathologic as explained in Table 2.

Pathologic halitosis with extraoral causes associated with various systems and their causative agent is explained in Table 3⁴ extraoral halitosis.

Table 1: Indicates the list of probiotic strains effective against the production of volatile sulfur compound causing halitosis

Author/year	Study design	Method effectiveness
Burton et al., 2006 ³⁰	Strain used— <i>S. salivarius</i> K12; Lozenges containing <i>S. salivarius</i> strain along with 3 days chlorhexidine mouth wash rinsing	Reduction in number of VSC by bacteriocin producing <i>S. salivarius</i> given after mouth wash
Iwamoto et al., 2010 ²⁷	Strain used— (1) <i>L. salivarius</i> WB21 (2.01×10^9); dissolution in mouth daily along with 840 mg of xylitolol tablets; (2) <i>L. reuteri</i> in the form of straw or tablet	Control of malodor and malodor-related factors ³¹ Improved physiological halitosis Reduction of <i>S. mutans</i> levels ³²
Kang et al., 2006 ³³	Strain used— <i>W. cibaria</i>	Inhibition of production of VSC by <i>F. nucleatum</i> Reduced production of H_2S , CH_2SH

Table 2: Genuine halitosis which is being further divided into physiologic and pathologic halitosis

Delusional halitosis	Pseudohalitosis and halitophobia
Pseudohalitosis	Objectively undiagnosed halitosis where the patient's oral malodor is not felt by others but his/her chief complaint is halitosis
Halitophobia	Patient declares his breath as bad smell fearing about having a continuous oral malodor in spite of the treatment ⁴
Genuine halitosis where breath malodor can be verified objectively	Two types: Physiologic halitosis Pathologic halitosis
Physiologic halitosis	Also termed as transient halitosis E.g., morning breath
Pathologic halitosis	Subclassified into • Oral malodor (fedor oris fetor ex oris) and • Extraoral ¹

Table 3: Pathologic halitosis with extraoral causes associated with various systems and their causative agent

System	Causative agent
Halitosis originating from respiratory system	<i>Pseudomonas aeruginosa</i> ¹²
Halitosis originating from gastrointestinal system	<i>Enterococcus faecalis</i> ¹² <i>Helicobacter pylori</i> ¹² <i>P. gingivalis</i> <i>T. denticola</i> <i>T. forsythia</i> ⁴
Halitosis originating from metabolic diseases	Cystinosis Hypernatremia Trimethylaminuria ¹²
Halitosis originating from drugs	Acetaminophen Chloral hydrate Disulfiram ¹²

The severity of oral malodor can be increased by periodontitis,^{13,14} deep periodontal pockets promoting the growth of gram negative bacteria *Treponema denticola* (*T. denticola*), *Porphyromonas gingivalis* (*P. gingivalis*), *T. forsythensis*, and *Fusobacterium nucleatum* (*F. nucleatum*),^{14,15} which form VSCs. diagnosis of oral malodor can be done by a variety of tests including direct and indirect methods. The tests include spoon test (assessing malodor from the dorsum of the tongue), dental floss odor test (interdental plaque odor assessment), and saliva odor test, etc.²

This multifactorial problem requires a well-defined approach for diagnosis and treatment. The cause of bad breath, i.e., due to oral causes or not, should be recorded in the halitosis history along with thorough medical and dental history.² Its management depends on the cause. The components which are hazardous and sensible to cause halitosis should be avoided including smoking, foods, and drugs. Unfavorable odor can be masked by nonpharmacological methods including mints, gums, mouth rinses, and sprays, etc.¹¹

Various chemical and mechanical methods reduce the volatile compound formation and therefore reduce the overgrowth of microbes causing halitosis.^{2,16} Treatment of oral diseases and improving oral hygiene also contributes to its prevention.¹

Suppression of oral malodor by probiotics by implication of indigenous oral microflora,² i.e., bacteriotherapy from healthy humans serves as an adjunct in the treatment of halitosis.¹

The term probiotics was initially proposed by Lilley and Stillwell in 1965. Fuller (1989) defined them as 'A live microbial food supplement, which beneficially affects the host animal by improving its microbial balance.'¹⁷ These are the microbes which have a distinct viability when given in sufficient doses provides various health benefits.¹⁸ Different probiotics bacterial strains include *Aerococcus*, *Enterococcus*, *Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Oenococcus*, *Pediococcus*, *Streptococcus*, *Carnobacterium*, *Tetragenococcus*, *Vagococcus*, and *Weissella* genera and are grouped into LAB, i.e., probiotic lactic acid bacteria.⁷ *Lactobacillus* and *Bifidobacterium* are the most commonly used probiotic strains. *B. Bifidum*, *B. dentium*, and *B. longum* are the species belonging to *Bifidobacterium* which are isolated from oral cavity and are used as a probiotic strain that forms the prevention and treatment of various oral diseases. *L. paracasei*, *L. plantarum*, *L. rhamnosus*, and *L. salivarius*.⁷⁻¹⁰ are the species belonging to *Lactobacillus* probiotic strain.¹⁹⁻²² *Saccharomyces boulardii* is the only yeast used as a probiotic strain.¹⁷

Probiotic strains belonging to *Lactobacillus*, *Bifidobacterium*, *Enterococcus*, and *Streptococcus* genera are used in synbiotic associations.²³ An ideal probiotic should be nontoxic with high cell viability and nonpathogenic.¹⁷ Different local and systemic mechanisms are involved in the action of probiotics. Different probiotics have different actions according to disease phase in which it is administered.²⁴ The basic mechanism involved is decreasing the vitality and growth of pathogen by occupying a niche that is colonized by pathogens and by adversely affecting the growth of that pathogen. It results in limiting the adherence of the pathogen to epithelial surface by modulating the epithelial permeability.¹⁷ Mode of action of probiotics in oral cavity is explained by its adhesion to the oral surface. The adhesion mechanism is explained on the basis of two model systems containing proteins and buffers in saliva-coated hydroxyapatite.²³ It is not possible to provide all the health benefits by a single probiotic strain, and specific health conditions are improved by specific strains. Probiotics generally leads to the improvement of lactose digestion, blood cholesterol, and controls intestinal pH 27×10^6 – 10^7 /kg/mL that should be present in food to provide health benefits.^{25,26}

Probiotic emerges as a cardinal tool and serves as a replacement to antibiotics in solving diseases like dental caries, periodontal diseases, and halitosis. Direct interaction, indirect interaction, and competitive exclusion agility explain the possible mechanism of probiotics in the treatment of these diseases in the oral cavity. Direct interaction results in inhibition of pathogen adhesion, colonization, and biofilm formation. Release of chemicals like hydrogen peroxide, *Bacteriocins* which results from competing with colonizing bacteria, explains the concept of competitive exclusion agility. Indirect actions constitute apoptosis by cytokines and effect on defense mechanisms, etc.¹⁷

The holistic approach and treatment plan for halitosis is accompanied by appropriate diagnosis based on the patient history.⁵ Management of both mouth-related and gut-related halitosis can be achieved by probiotics.²⁷ Efficacious probiotics strains or bacteriocin producing microorganisms are considered to be effective agents against halitosis. Probiotics strains to limit the growth of bacteria causing halitosis includes *Streptococcus salivarius* K12, *Lactobacillus salivarius* WB2,⁵ *E. coli* Nisle 1917, and *Weissella confusa* isolates.²⁷ Halitosis or oral malodor occurs due to the production of VSCs (H_2S and CH_4S) from the amino acids which occurs due to degradation of proteins from the gram negative anaerobic bacteria including⁷ *F. nucleatum*, *P. gingivalis*, *Prevotella intermedia*, and *T. denticola*.

The VSCs constitute H_2S from cysteine produced by *Peptostreptococcus*, *Bacteroides*, *Selenomonas* bacterial species, and CH_2SH from methionine produced by *P. gingivalis*, *P. intermedia*, and *T. denticola* bacteria resulting in halitosis.²⁸

Species associated with halitosis include *Atopobium parvulum*, *Eubacterium sulci*, *Fusobacterium periodontium*, *Solobacterium moorei*, and *Streptococcus*.²⁹

Probiotic strains used as an adjunct to halitosis require the bacteria from the same ecosystem (Colodner et al., 2003; Reid et al., 2003). Strict scientific criteria along with phenotypic profile in controlled clinical trials are a necessity to probiotics bacteria. Oral malodor most commonly originates from the anaerobic bacteria residing in the dorsum of tongue. Major contribution to halitosis is marked by proteolytic microbes producing bacteriocin and adhering to the adhesive molecules on the cell surface of the tongue (Reid and Burton, 2002), De Boever, and Loesche (1995)

by degrading host proteins. Reduced production of by-products that produce odor and effective colonization is the prerequisites for a probiotics strain for treating halitosis.³⁰

CONCLUSION

Probiotics emerging as a new area of research in the prevention and treatment of halitosis is gaining momentum with time. Probiotic strains antagonizing the production of VSC producing bacteria causing halitosis and providing oral benefits define its potential in the future. Long-term studies are required to increase its affinity and to discover more probiotics strains preventing oral malodor.

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