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REVIEW ARTICLE

Antibiotics are Passe: Take a Look at Probiotics

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ABSTRACT

"Part of the secret of success in life is to eat, what you like and let the food fight it out inside."

—Mark Twain.

This age—old quote was probably the first reference to a relatively novel group of organisms fondly known as 'probiotics'. Probiotics are live organisms that alter the composition or metabolic activities of the microbiota, or to modulate immune system reactivity in a way that benefits our health. In other words, they are microorganisms good for our health. To achieve this, probiotics actively 'compete' with pathogenic bacteria for attachment sites, nutrition, etc. Probiotics are also beneficial by eliminating the toxins produced by pathogens, hereby rendering them invalid.

Research surrounding probiotics has historically focused on digestive health. Over recent years, scientists have been investigating the potential immune benefits of probiotics, as well as other benefits beyond the recognized area of gut.

This article attempts to summarize the mechanisms of action of probiotics with a brief overview of some of the oral benefits of certain probiotics organisms.

Keywords: Probiotics, Functional foods, Oral health.

INTRODUCTION

Physiologically active compounds derived from certain bacterial strains and products of plant and animal origin are referred to as "functional foods"[1]—they are beneficial for human health and reduce the risk of chronic diseases.

The best known functional compounds include probiotics, prebiotics and natural antioxidants.

They can be obtained by biotechnological methods and by extraction from plant or animal tissues.

Probiotics are defined as live microorganisms, which when administered in adequate amounts, confer a health benefit on the host.

– FAO/WHO, 2002

HISTORY

In the early 1900s, Ukrainian bacteriologist and Nobel Laureate Ilya Metchnikoff (1908), while studying the human intestinal flora, developed a theory that senility is caused by poisoning of the body by the products of some of these bacteria (autointoxication). To prevent the multiplication of these organisms, he proposed a diet containing milk fermented with lactobacilli. He subjected Bulgarian peasants to experimental consumption of sour milk for longevity of life.

The term *Probiotic*, as opposed to antibiotic was initially proposed by Lilley and Stillwell in 1965. The first species to be introduced in research was Lactobacillus Acidophillus by Hull et al in 1984 followed by Bifidobacterium Bifidum by Holcombh et al in 1991.[2]

PROBIOTIC STRAINS

Although most probiotics are bacteria, they can be molds and yeasts as well. Some popular probiotics include- *Lactobacillus acidophilus, Lactobacillus rhamnosus, Bifidobacterium bifidum, Bifidobacterium longum, Saccharomyces boulardii.* Other common ones are *Lactobacillus salivarius, Lactobacillus reuteri, Lactobacillus casei, Streptococcus thermophilus* and *Enterococcus faecium.*[3]

BIOLOGICAL EFFECTS OF PROBIOTICS

Some of the most studied biological effects of probiotics on human health include:

- Reduction of cancer risk
- Stimulation of immune system
- Decrease of menopause symptoms
- Maintenance of urinary tract health
- Improvement of gastrointestinal health
- Antiinflammatory effects
- Reduction of blood pressure
- Maintenance of vision
- Antibacterial and antiviral effects
- Reduction of osteoporosis
- Antiobese properties.

They are proven to be effective against:
- Antibiotic-associated diarrhea
- Acute infectious diarrhea
- Irritable bowel syndrome
- Atopic dermatitis.[4-6]

MECHANISM OF ACTION

- Adherence and colonization in the gut
- Suppression of growth of pathogenic bacteria by preventing their epithelial binding
- Production of antimicrobial substances (organic acids, bacteriocins, hydrogen peroxide, diacetyl acetaldehyde, lactoperoxidase system, lactones, etc)
- Improvement of intestinal barrier function
- Controlled transfer of dietary antigens
- Stimulation of mucosal and host immunity
- Degradation of toxins
- Reduction of gut pH.[5,6]

PROBIOTICS IN THE ORAL CAVITY

An essential requirement of an organism to be an 'oral probiotic' is its ability to adhere and colonize surfaces in the oral cavity.

The most common studied organism in the oral cavity is *Lactobacilli*.

MECHANISM OF ACTION OF PROBIOTICS IN ORAL CAVITY

In oral cavity, probiotics can create a biofilm acting as a protective lining for oral tissues against oral diseases. Such a biofilm keeps bacterial pathogens off oral tissues by filling a space pathogens would invade in the absence of biofilm, and competing with cariogenic bacteria and periodontal pathogens growth.

Probiotics and Cariogenic Pathogens

Probiotics can reduce the risk of a high *Streptococcus mutans* level occurrence in the oral cavity. *Lactobacillus rhamnosus* and *lactobacillus casei* have proven potential to hamper the growth of oral streptococci.

Probiotics and Periodontal Disease

Krasse et al showed a significantly reduced gingival index and bacterial plaque amount in patients treated with *L. reuteri* than in a placebo group and concluded that this probiotic was effective to reduce gingivitis and bacterial plaque deposition in patients with moderate-to-severe gingivitis.

Probiotics and Halitosis

After taking *Weissella cibaria*, reduced levels of volatile sulfide components produced by *Fusobacterium nucleatum* were observed by Kang et al. A marked reduction on the levels of hydrogen sulphide is noted after gargling with *W. cibaria* containing rinse. The possible mechanism in the volatile sulfide components reduction is the hydrogen peroxide generated by *W. cibaria* that inhibits the proliferation of *F. nucleatum*.

Probiotics and Candida Albicans

C. albicans is a leading cause of infection in oral cavity. It is particularly common in the elderly and immunocompromised patients. Hatakka et al showed a reduced prevalence of *C. albicans* after taking probiotics in cheese containing *L. rhamnosus* and *Propionibacterium freudenreichii ssp. shermanii*. Results obtained by Koll et al when assessing the effects of various *Lactobacillus* strains in oral cavity were markedly different; most strains suppressed growth of periodontal pathogens, including *Aggregatibacter actino-mycetemcomitans; Porphyromona gingivalis, P. intermedia*, and cariogenic *S. mutans*. No inhibition was found, however for *C. albicans* growth.

RESIDENCE TIME OF PROBIOTICS IN ORAL CAVITY

Residence time of probiotics in oral cavity after treatment withdrawal was studied by Çaglar et al. A reduced *S. mutans* level was shown after a two-week use of a *L. reuteri*-enriched yogurt; effects were observed during use and for a few days after discontinuation. A loss of *L. reuteri* colonization was observed by Wolf et al. Two months after having discontinued probiotic *use. L. rhamnosus* administration and oral cavity colonization was studied by Yli-Knuuttila et al. The authors concluded that permanent colonization in oral cavity was unlikely (although possible in some cases) and suggested the probiotic to be used on a regular basis.[2]

SPECIFIC ORGANISMS

1. *Lactobacillus rhamnosus*
   - Hampers growth of oral streptococci, particularly caries pathogen *Streptococcus mutans*
   - Reduction of *Candida albicans.*
2. *Weisella cibaria*
   - Coaggregates with *Fusobacterium nucleatum*, hence forming a barrier, which prevents the colonization of pathogenic bacteria
   - Reduces halitosis by preventing formation of volatile sulphur compounds.
3. *Lactobacillus reuteri*
   - Decreases plaque deposition
   - Reduces gum bleeding
   - Inhibits *Porphyromonas gingivalis* and *Prevotella intermedia* hence reducing gingivitis
   - Effective against *Streptococcus mutans*, hence decreasing risk of dental caries.
4. *Streptococcus salivarius*
   - Inhibits volatile sulphur compounds formation by *Fusobacterium nucleatum* (causative of oral malodour) by competing for colonization sites with species, which cause an increase in the levels of volatile sulfide components.

5. *Lactobacillus acidophilus, Lactobacillus fermentum*
   Decline in candida species in mice.
6. *Streptococcus thermophillus, Lactobacillus lactis*
   Decreased cariogenic bacterial levels.

DOSAGES

Generally, 5 billion Colony Forming Unit's per day in children and more than 10 billion Colony Forming Units per day in adult is associated with a significant study outcome. Higher dosages are not unsafe, but may be expensive and unnecessary.

Probiotics are generally sold as capsules, powder, tablets, and liquids or incorporated into food.[7]

CONTROVERSIES

1. Optimal probiotic species, doses and/or formulation remain unknown.
2. Concept is unclear, if combination therapy is superior to single-agent therapy.
3. Ideal route of administration yet to be proven.
4. Pairing of individual probiotic organisms with specific diseases has not been established.[8]

Key Points about Probiotics[7]

Effectiveness	Antibiotic-associated diarrhea, infectious diarrhea, irritable bowel syndrome, atopic dermatitis.
Adverse effects	• Common: flatulence, mild abdominal discomfort • Severe/rare: septicemia
Interactions	None known
Contraindications	Severe immunocompromised patients
Dosage	• 5 to 10 billion colony forming units per day for children • 10 to 20 billion colony forming units per day for adults.

CONCLUSION

There is considerable potential for the benefits of probiotics consumption over a wide range of clinical conditions. Ongoing research will continue to identify and characterize existing strains of probiotics, identify strain-specific outcomes, and determine optimal doses needed for certain results.

With the current focus on disease prevention and the quest for optimal health at all ages, the probiotic market potential is enormous. Health professionals are in ideal position to guide patients toward appropriate prophylactic and therapeutic uses of probiotics that deliver the desired beneficial health effects.

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