REVIEW ARTICLE

PRO, PRE, SYNBIOTICS & HUMAN HEALTH – A TREATISE

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The word "probiotic bacteria" which also known as good bacteria, friendly bacteria or beneficial bacteria refers to the live bacterial organisms which live and work in our digestive tracts and provide us health benefits. The substances that contain microorganism or bacteria that are beneficial to the host are known as “Probiotics”. Most of the probiotic strains belong to lactobacilli and bifidobacteria. These two have many strains and some newer strains are under research. On the other hand “prebiotics” are non-digestible food ingredients that stimulates the growth and/or activity of bacteria in the digestive system in way claimed to be beneficial to health. They are first identified and named by Marcel Roberfroid in 1995. Roberfroid offered a refined definition in the 2007 journal of nutrition stating “A prebiotic is a selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal micro flora that confers upon host well being and health”. “Synbiotic” refers to nutritional supplements combining probiotic and prebiotic in a form of synergism, hence synbiotic. The combinational use of probiotic and prebiotic is often described as synbiotic. Synbiotic has a great importance in the micro flora management procedure. In Japan, certain foods including probiotics and prebiotics have been approved as the Food for Specified Health Uses (FOSHU) by the Japanese government. Probiotics and probiotics individually have a great significance in human health. The proposed mechanism of action of probiotics include the improvement of disrupted intestinal micro flora in compromised hosts. They are also effective in reducing Antibiotic-associated diarrhea (AAD), blood pressure, colon cancer, lactose intolerance, Helicobacter pylori, cholesterol and many other diseases. This article provides an overview about probiotics, probiotic bacterial strains, prebiotics, their importance and how they combinationally play important role in human health.

Key words: Prebiotics, Probiotics, Synbiotic, Human health, AAD.

INTRODUCTION

Probiotics are rapidly becoming a popular and important tool for preserving our natural health. The concept that probiotics are based on however is not a new one. In her book "Bacteria For Breakfast" Dr. Kelly Karpa says, "Fermented milk products which contain probiotics have been used for centuries. According to Persian tradition, Abraham of the Old Testament owed his longevity to ingestion of fermented milk. King Francis I of France was reportedly cured of an illness after eating yogurt in the early 1500’s. So you see this "probiotic" stuff is not new. Probiotics have been around for more than 5000 years. Probiotics are commonly consumed as part of fermented foods with specially added active live cultures; such as in yogurt, soy yogurt, or as dietary supplements. Prebiotics are non-digestible food ingredients that stimulate the growth and/or activity of bacteria in the digestive system in ways claimed to be beneficial to health. They were first identified and named
by Marcel Roberfroid in 1995. As a functional food component, prebiotics, like probiotics, are conceptually intermediate between foods and drugs. Depending on the jurisdiction, they typically receive an intermediate level of regulatory scrutiny, in particular of the health claims made concerning them. Using prebiotics and probiotics in combination is often described as symbiotic, but the United Nations Food and Agriculture Organization (FAO) recommends that the term “synbiotic” be used only if the net health benefit is synergistic (Cencic and Chingwaru, 2010). A further restriction is to require that the prebiotic be shown to increase the population and/or function of the probiotic it is paired with. The microbiota of the human large intestine influences health and well-being. Whereas it has long been accepted that gut bacteria play a role in host pathogenesis, current opinion is that certain microflora components can have beneficial effects on gastroenteritis resistance, blood lipids, antitumor properties, lactose tolerance, and gastrointestinal immunity. Many factors affect the composition of the large-intestinal microbiota in humans. Combined uses of probiotics and prebiotics could improve the survival of the probiotic organism, because its specific substrate is readily available for its fermentation, and result in advantages to the host that the live microorganism and prebiotic offer.

**Probiotic bacteria**
The term "probiotic bacteria" (also known as good bacteria, friendly bacteria or beneficial bacteria) refers to the live bacterial organisms which live and work in our digestive tracts and which provide us with health benefits. There are many different species which live in our digestive tract and most of these are bacterial. Scientific estimates place the number of bacterial species to be between 300 (Guarner and Malagelada, 2003) and 1000 (Sears, 2005) with many estimates around 500 (Steinhoff, 2005; O’Hara and Shanahan, 2006). However, this area of research is in its infancy and it is still not possible to culture most of these bacteria. We therefore think that the actual number of bacteria in the digestive tract are likely to be much greater! Lactic acid bacteria and bifidobacteria are the most common types of microbes used as probiotics. Although every person has a unique mix of organisms that make up their intestinal flora, some species of microorganism are more common and numerous than others. The key players in human gut flora are Lactobacillus and Bifidobacterium. There are many different species of these probiotic bacteria, which we can see in our list below:

**Lactobacilli**
- Lactobacillus acidophilus
- Lactobacillus brevis
- Lactobacillus bulgaricus
- Lactobacillus casei
- Lactobacillus helveticus
- Lactobacillus plantarum
- Lactobacillus reuteri
- Lactobacillus rhamnosus

**Bifidobacteria**
- Bifidobacterium bifidum
- Bifidobacterium infantis
- Bifidobacterium lactis
- Bifidobacterium longum

**Prebiotics**
A prebiotic is a nondigestible food ingredient that beneficially affects the host by selectively stimulating the growth, activity, or both of one or a limited number of bacterial species already resident in the colon (Gibson and Roberfroid, 1995). Prebiotics are carbohydrates (such as oligosaccharides), but the definition may include non-carbohydrates. The most prevalent forms of prebiotics are nutritionally classed as soluble fiber. To some extent, many forms of dietary fiber exhibit some level of prebiotic effect. They were first identified and named by Marcel Roberfroid in 1995. Roberfroid offered a refined definition in the Journal of Nutrition (Roberfroid, 2007) stating: "A prebiotic is a selectively fermented ingredient that allows specific changes, both in the composition and/or activity in the gastrointestinal microflora that confers benefits upon host well-being and health".

**Sources**
Traditional dietary sources of prebiotics include soybeans, inulin sources (such as Jerusalem artichoke, jicama, and chicory root), raw oats, unrefined wheat, unrefined barley and yacon. Some of the oligosaccharides that naturally occur in breast milk are believed to play an important role in the development of a healthy immune system in infants.
Table 1. Top 10 foods containing prebiotics (Moshfegh et al 1999)

<table>
<thead>
<tr>
<th>Food</th>
<th>Prebiotic fiber content by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Chicory Root</td>
<td>64.6%</td>
</tr>
<tr>
<td>Raw Dandelion Greens</td>
<td>24.3%</td>
</tr>
<tr>
<td>Raw Garlic</td>
<td>17.5%</td>
</tr>
<tr>
<td>Raw Leek</td>
<td>11.7%</td>
</tr>
<tr>
<td>Raw Onion</td>
<td>8.6%</td>
</tr>
<tr>
<td>Cooked Onion</td>
<td>5%</td>
</tr>
<tr>
<td>Raw Asparagus</td>
<td>5%</td>
</tr>
<tr>
<td>Raw Wheat bran</td>
<td>5%</td>
</tr>
<tr>
<td>Whole Wheat flour, Cooked</td>
<td>4.8%</td>
</tr>
<tr>
<td>Raw Banana</td>
<td>1%</td>
</tr>
</tbody>
</table>

Synbiotics
Using prebiotics and probiotics in combination is often described as synbiotic, but the United Nations Food and Agriculture Organization (FAO) recommends that the term “synbiotic” be used only if the net health benefit is synergistic. A further restriction is to require that the prebiotic be shown to increase the population and/or function of the probiotic it is paired with. *e.g.* bifidobacteria and fructo-oligosaccharides (FOS), lactobacillus rhamnosus GG and inulins, bifidobacteria or lactobacilli with FOS or inulins or galactooligosaccharides (GOS).

Role of pro, pre-synbiotics for healthy human gut
Many factors affect the composition of the large-intestinal microbiota in humans. These include the age, susceptibility to infections, nutritional requirements, and immunologic status of the host and the pH, transit time, interactions between flora components, and presence and availability of fermentable material in the gut. The gastrointestinal tract of newborns is inoculated primarily by organisms originating from the mother’s vagina and feces and from the environment. For newborns delivered by cesarean birth this latter factor is of particular importance. Bacterial populations develop during the first day of life. Not surprisingly, facultative anaerobic strains such as *Escherichia coli* and *Streptococci* initially exist in highest numbers (Rotimi and Duerden, 1981; Stark and Lee, 1982). These bacteria may subsequently create a highly reduced environment that allows the growth of strictly anaerobic species. Soon after delivery, the infant may be weaned from breast milk to formula. Differences in the fecal flora of breast-fed and bottle-fed infants exist and have been associated with a lower risk of gastrointestinal infection in breast-fed infants. Although the data are conflicting, there is some evidence that the microflora of breast-fed infants is dominated by populations of bifidobacteria (Benno et al 1984), an observation first promoted in the early work of Tissier (Tissier, 1905). In contrast, formula-fed infants are thought to have a more complex flora with no one bacterial genus showing a numerical predominance. The high incidence of bifidobacteria has been cited as one possible explanation for the purported health advantages. Although the ecosystem development is undoubtedly influenced by both host and environmental factors, some postulations directly attribute this development to the feeding regime as follows:

1. Oligosaccharides, including *N*-acetylglucosamine (Gyorgy, 1953), glucose, galactose, and fucose oligomers or certain glycoproteins which form a significant proportion of human breast milk, may be specific growth factors for bifidobacteria.
2. Low protein content and reduced buffering capacity of human milk may allow elevated growth of bifidobacteria (Bullen et al 1977; Willis et al 1973). The nature, type, absorption, and quantity of milk proteins present in the feed may also exert an effect.
3. Certain compounds, including lactoferrin and some lipids, inhibit microorganisms (Raibaud, 1988).
4. Certain bacteria may stimulate immunoglobulin molecules such as secretory immunoglobulin A.
In an early study by Robinson and Thompson, a Lactobacillus acidophilus supplement given to formula-fed infants was thought to improve weight gain. Other studies directed the use of probiotics to specific clinical disorders. In a well-designed study, Isolauri et al showed that oral rehydration that included a strain of L. casei promoted recovery from acute diarrhea in children. Results from a lactulose-mannitol permeability test showed that no mucosal disruption occurred. The duration of diarrhea was reduced from 2.4 d in a placebo group to 1.4 d in the intervention group.

Bifidobacteria have also been used in microbial food supplements for infants, both individually and in combination with lactobacilli (Benno et al 1984). Tojo et al observed that oral administration of Bifidobacterium breve may be effective against campylobacter-induced enteritis in children. Encouraging results have also been proposed for the use of bifidobacteria in rotaviral infections (Saavedra et al 1994). Randomly assigned infants < 24 months of age who were admitted to a chronic medical care facility received standard infant formula or formula supplemented with B. bifidum and Streptococcus thermophilus. Thirty-one percent of patients in the control group, but only 7% of those in the supplemented group, developed acute diarrhea. Moreover, 39% of the control subjects, but only 10% of the supplemented group, shed rotavirus in stools at sometime during the 17-months study (Saavedra et al 1994). Other applications of bifidobacterial probiotics in infants have been directed toward reducing the growth of Candida albicans and the incidence of enterocolitis (Tasvac, 1964).

A prebiotic is a nondigestible food ingredient that beneficially affects the host by selectively stimulating the growth, activity, or both of one or a limited number of potentially beneficial commensal bacteria in the colon, thus stimulating the bacteria to grow, become metabolically activated, or both; and 3) be able as a consequence to alter the colonic microflora toward a more healthier composition. It may be that future developments in the study of prebiotics may include aspects of their effect on pathogenic flora components. A possible example of the latter is the ability of cellobiose to attenuate virulence in Listeria monocytogenes (Park and Kroll, 1993). Bifidobacteria are reasonable target organisms for prebiotics. B. infantis and B. breve are thought to be predominant in infants (Drasar and Roberts, 1990), whereas B. adolescentis and B. longum are prevalent in adults (Mitsuoka, 1984).

Another possibility in microflora management procedures is the use of synbiotics, in which probiotics and prebiotics are used in combination (Gibson and Roberfroid, 1995; Roberfroid, 2007). The live microbial additions (probiotics) may be used in conjunction with specific substrates (prebiotics) for growth (e.g. a fructooligosaccharide in conjunction with a bifidobacterial strain or lactitol in conjunction with a lactobacillus organism). This combination could improve the survival of the probiotic organism, because its specific substrate is readily available for its fermentation, and result in advantages to the host that the live microorganism and prebiotic offer.

CONCLUSION

Probiotics are not the same thing as prebiotics - nondigestible food ingredients that selectively stimulate the growth and/or activity of beneficial microorganisms already in people's colons. When probiotics and prebiotics are mixed together, they form a symbiotic. It is possible to keep the gut microbiota healthy of infants and adults through dietary supplementation. The improved validity that a molecular approach to gut microbiology offers will accelerate this potential and allow for definitive assessment of flora changes.

REFERENCES


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