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The Association among Diet, Prebiotic and Probiotic

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The human gastrointestinal tract that typically refers to stomach and intestine is colonized by an intricate community of microorganisms. The stomach is a home of typically 10^3 colony forming units (CFU)/g content [1]. The large intestine is the main colonization site of more than 500 indigenous microbial species which can reach up to 10^{12} CFU/g lumen contents [1,2]

A wide range of compounds that have both positive and negative effects on gut physiology is produced through fermentation process by predominantly strict anaerobe gut microflora. For instance, short-chain fatty acids (SCFA), mainly butyrate supplies energy metabolism for the large gut mucosa and colonic cell growth. This SCFA is the end fermentation products of complex carbohydrate and protein that usually present in human diet. In contrast, H_2S produced by sulfate-reducing bacteria is highly toxic and may induce ulcerative colitis [1].

From the host's perspective, the key function of gut microflora is to prevent colonization by potentially harmful microorganisms. The imbalanced gut microflora has been linked to the development of certain disorders such as gastroenteritis, colon cancer and inflammatory bowel disease [3]. The composition of gut microflora is considered to be fairly stable over long periods. However, numerous factors such as competition for nutrients, metabolic interaction among bacteria, various host condition and individual dietary preferences may influence alteration of the pattern [4]. Therefore, it is of the foremost interest to manipulate the gut microflora composition toward an increased number of beneficial bacteria that provide health promising properties to the gut.

The groups of beneficial bacteria that help maintain health and treat disease is broadly known as probiotic. Several definitions of probiotic have been suggested for over the years. Fuller [5] defined probiotic as a live microbial food supplements which have beneficial effects on the host by improving its intestinal microbial balance.

A probiotic bacterium should fulfill certain criteria to be described as useful. These include acid and bile stability, adherence to intestinal cells, persistence for some time in the gut, ability to produce antimicrobial substances, antagonism against pathogenic bacteria, ability to modulate the immune response, being of human origin and having generally regarded as safe (GRAS) status [6].

In human, probiotic has been associated with lactobacilli (e.g. *Lactobacillus acidophilus*, *L. delbruekii* and *L. casei*) and bifidobacteria (e.g. *Bifidobacterium bifidum*, *B. adolescentis*, *B. infantis* and *B. longum*). Other known bacteria

include streptococci (e.g. *Streptococcus lactis* and *S. salivarius* ss. thermophilus), nonpathogenic *E. coli* and *Saccharomyces boulardii* [7].

A practical approach in increasing the number and activities of probiotic is through dietary supplementation, particularly with intake of the so called prebiotic. Gibson and Roberfroid [7] defined a prebiotic as 'a non digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, and thus improves host health'.

They revealed that food constituents can be categorized as prebiotic if meet the following requirements: 1) Resistant to hydrolysis and absorption in the upper part of gastrointestinal tract; 2) Act as selective substrate for one or a limited number of beneficial bacteria commensal to the colon; 3) Able to alter the colonic flora in favor to healthier composition; and 4) Induce luminal or systemic properties that are beneficial to the host health. Fructooligosaccharides (FOS), inulin, lactulose and galactooligosaccharides are commercially available prebiotic of proven efficacy.

Inulin and FOS can be found in human breast milk and in food such as banana, asparagus, leeks, onion, garlic, wheat, chicory and tomatoes [8]. Galactooligosaccharides (GOS), a mixture of oligosaccharides derived from lactose is frequently used as supplement in food and infant formula milk [8,9]. In their in vitro study, Wang and Gibson [9] demonstrated that FOS and inulin are selectively fermented by most strains of bifidobacteria.

The prebiotic effects of inulin and oligofructose in vivo have also been shown in some studies [10,11]. Moreover, the ability of these oligosaccharides in increasing the numbers of gut probiotic, particularly bifidobacteria has been shown in many human feeding studies. Breast milk is rich in human oligosaccharides and therefore the number of bifidobacteria in the gut microflora of breast-fed infants is higher than that in formula-fed infants [7].

The predominance of bifidobacteria in breast-fed infants is usually associated with lower risk of intestinal infection. However, Moro et al [12] reported that after 28 days of feeding, the number of fecal bifidobacteria and lactobacilli in infant fed with a cow milk supplemented with FOS and GOS were significantly increased compared to the placebo group.

The link between prebiotic and probiotic has been pronounced to enhance the efficacy of the both agents in maintaining the health of intestine. Synbiotics have been defined as 'a mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal track, by selectively stimulating the growth and/or by activating the metabolism of a limited number of health promoting bacteria, and thus improving host welfare' [7].

There are only few studies carried out to investigate the efficacy of synbiotics in human. Bouhnik et al [13] investigated the effect of symbiotic containing *Bifidobacterium* spp. and inulin fermented milk in healthy people. The authors reported that intake of *Bifidobacterium* spp. significantly increased fecal bifidobacteria, but no extra numbers of that particular probiotic was observed merely due to the addition of inulin. However, 2 weeks after trials, the volunteers who received symbiotic product had significantly higher number of *Bifidobacterium* spp. compared to those receiving probiotic alone. In addition, it was found that the trend whereby *Bifidobacterium* spp population decreases in the gut microflora of eldery may be reversed by the consumption of inulin [12].

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