Probiotics, gut microbiota and health

The human gut is a huge complex ecosystem where microbiota, nutrients, and host cells interact extensively, a process crucial for gut homeostasis and host health. The various bacterial communities making up the gut microbiota have many functions including metabolic, barrier effect, and trophic functions. Hence, any dysbiosis could have negative consequences in terms of health and many diseases have been associated with the impairment of the gut microbiota. The close relationship between gut microbiota, health, and disease, has led to great interest in the use of probiotics (i.e. live micro-organisms), and prebiotics (i.e. non-digestible substrates) to positively modulate the gut microbiota in order to prevent or treat certain diseases.

How do probiotics act?

The mechanisms of action of probiotics relate to the modulation of the host microbiota.

One of the first suggested modes of action, the resistance to colonization exerted against pathogenic bacteria thus preventing or limiting their colonization. Bacterial inhibition may be due to the production of broad-spectrum inhibition bacteriocins, the metabolites such as short-chain fatty acids inducing a lowered pH decreasing the favorability for bacterial growth, or act as biosurfactants with antimicrobial activity. This barrier effect can also act by competing for binding sites, and by inhibiting adhesion.

The second mode of action concerns the improvement of the barrier function of the gut mucosa which relates to the quality of tight junctions between intestinal epithelial cells. Mucus cells act as a protective layer prevent direct contact with bacteria of the intestinal lumen. Probiotics can thus act at the level of signaling pathways leading to an increase in either or both of the mucus layer or to production of defensins. They can also act on proteins of tight junctions by improving their ability to function as a physiologic barrier.

The third mode of action, modulation of the immune system, occurs and depends upon the more than 70% of immune cells located at the gut level, especially in the small bowel, making up the gut associated lymphoid tissue (GALT). Activation of the immune response requires recognizing receptors of immunity cells by microorganisms on the gut surface. Activation of regulatory T-cells and differentiation of T-helper lymphocytes induce the production of pro- or anti-inflammatory cytokines. Probiotics may have a balancing effect on the cytokine profile in reduction of inflammation.

Probiotics can also directly provide beneficial effects via beta-galactosidase or other enzymes improving the digestive symptoms of patients.

Probiotics project protection through their structures such as DNA, and/or their metabolites (especially short-chain fatty acids). Their action may be direct, related to digestive colonization, or indirect because these strains will modulate the microbiota, by increasing the inoculum of bacteria with beneficial effects.

Probiotics today in human medicine

Probiotics and infectious diarrhea: One of the first recommendations for probiotic use was the treatment and/or the prevention of diarrhea. A meta-analysis of 63 clinical trials reported significant benefits of probiotics for acute diarrhea, with a shortened duration of diarrhea and decreased number of stools. Another indicator for probiotics is diarrhea associated with antibiotic intake. Administration of probiotics clearly allows rebuilding of a microbiota barrier. The result of many meta-analyses and reviews suggest their effectiveness when administrated with antibiotics.

Probiotics and Inflammatory bowel disease (IBD): IBD (Crohn' s disease, and ulcerative colitis) are chronic diseases of unknown etiology occurring increasingly over the past few decades. Patients present with ulceration of the small bowel or colon mucosa, alternating between periods of activity and remission. Some researchers have reported dysbiosis and a decrease of microbial diversity in patients presenting with IBD besides genetic predisposition. Studies found probiotics application can prolong the remission and decrease the clinical signs of IBD.

Probiotics and irritable bowel syndrome: Irritable bowel syndrome is an intestinal disorder characterized by abdominal pain and a chronic disorder of diarrhea and/or constipation. Some data suggests that probiotics can improve dysbiosis and decrease inflammation of the intestinal mucosa.

Probiotics and allerg: Studies have found the microbiota between allergic and non-allergic people vary and probiotics assist in improving microbiota diversity and balancing the immune system.

Probiotics for obesity: The authors of some mice and human studies have reported benefits of probiotics on obesity, and the reason may be due to how probiotics can affect food intake regulatory signals through gastrointestinal pathways. Another interesting finding revealed that fecal metagenomics markers differentiated the obese from non-obese more easily than genome markers, providing important direction in continuing research on microbiota modulation in the management of obesity.