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Short Commentary

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The human gastrointestinal tract and the significance of intestinal probiotics

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Abstract

The human gastrointestinal tract comprises of mouth, pharynx, esophagus and stomach, the small intestines, large intestines and the anus. The main function of the GIT is digestion, processing and absorption of food. The GIT also serves as a prominent part of the immune system. The intestine is densely populated with bacteria, making it an important site for host-microbe interactions. Although a lot of research has mainly focused on intestinal pathogens that can cause localized and systemic infections, many intestinal microflora are not harmful, but, instead, are beneficial to the host. These microflorae that are beneficial to the host are known as the Lactic acid bacteria. Lactic acid bacteria are also called probiotics. Probiotic are used as health adjuncts to provide a wide variety of health benefits.

Keywords: Gastrointestinal tract; Probiotics; Lactobacilli; Health significance.

The human gastrointestinal tract

The human gastrointestinal tract [GIT] is approximately 7.5-meter-long and consists of upper and lower portions. The upper GIT comprises of the mouth, pharynx, esophagus and stomach and the lower GIT consists of the small intestines, large intestines and the anus. The main function of the GIT is digestion, processing and absorption of food. The GIT also serves as a prominent part of the immune system. Digestion is the process of breaking down food into molecules small enough for the body to absorb. The path of food through the human digestive system includes the following organs and structures listed below. The mouth includes the teeth, tongue, saliva, mucin, buffers, antibacterial agents, and amylase. All these help in chewing, taste and preliminary digestion of the ingested food [1].

The pharynx leads to both the trachea and the esophagus. The esophagus is the tube from the pharynx to the stomach. Food is moved along the esophagus by peristalsis, wave-like contractions of the muscles in the walls of the esophagus. The lining of the esophagus secretes mucus to lubricate the ball of food. There are sphincter muscles (rings of constricting muscles) at the top and bottom of the esophagus [1].

The stomach is a J-shaped, expandable sack, normally on the left side of the upper abdomen. Several muscle layers surround the stomach, serving to churn food. The stomach can expand to hold about 2 L [=1/2 gal] of food. The stomach contains hydrochloric acid [HCl] with a pH about 1.5 to 3, which kills bacteria and helps denature the proteins in our food, making them more vulnerable to attack by pepsin. The stomach secretes mucus to protect itself from being digested by its own acid and enzymes. The stomach also secretes pepsin, an enzyme to digest protein. The average person secretes about 400 mL of gastric juice per meal, containing 50 to 300 µg pepsin/mL. The cardiac sphincter closes off the top end of the stomach and the pyloric sphincter closes off the bottom [1].

The small intestine has a length of about 6 m. The surface of the small intestine is wrinkled and convoluted to produce a greater surface area for absorption. The total surface area is about 600 m^2. Most enzymatic digestion occurs here. The secretions of the small intestine include amylase, maltase, sucrase, lactase, etc. to digest carbohydrates and lipase to digest fats. Several other associated organs secrete chemicals into the small intestine to aid in digestion: the pancreas secretes enzymes like trypsin, chymotrypsin, and alkali solutions like bicarbonate as buffers and the liver and gall bladder make and secrete bile. Bile contains no enzymes, but salts to emulsify fat so it can be digested. The surface area per unit length is highest in the jejunum and decrease gradually in the distal portion of the small intestine. Ridges around the lumen help to increase the surface area by 3-fold and this is further expanded by another 4-10 folds with microvilli. The microvilli possess glycocalyx which confers the microvilli with negative charge. Besides that, goblet cells function to produce mucus that covers the glycocalyx. This layer forms the unstirred water lay that limits passive diffusion and uptake of microparticles.

The small intestine includes three sections

1. Duodenum: The first and the proximal portion of the small intestine. Its pH in the range of 5.5 to 6.5

2. Jejunum: The second portion has pH in the range of 6.0 to 7.0

3. Ileum: The third and distal portion of the small intestine has pH in the range of 6.5 to 7.0

The valve between the small and large intestines is the ileocecal valve which separates the two intestines. The large intestine or colon begins with a blind pouch called the cecum. The pH of the colon is in the range of 5.5 to 7.0. In humans, this terminates in the appendix, a finger-like extension which may function in the immune system. The large intestine functions to re-absorb water and in the further absorption of nutrients.

In a fasted state, the pH in the stomach is approximately 1.7 and gradually increases to 4.6 in the duodenum as a result of secretions of bicarbonate ions via pancreatic duct. The pH gradually increases from 6.0 to 8.0 from the proximal jejunum to the distal ileum. The pH then drops to 5.0 in the colon due to products of microbial digestion. In a fed state, pH of the stomach can rise as high as 7.0, gradually decreasing with time and finally reaching the fasted value after 3.0 hours. One to two hours after intake, the transit of food down to the small intestine caused the pH of the proximal jejunum to fall to approximately 4.5. In addition to pH changes, transit time also varies between fed and fasted states. In an empty stomach, solids may reside for 0.5 to 3.0 hours whereas 200 ml of water has a transit half-life of 0.1 to 0.4 hours. The transit time is approximately 3.0-5.0 hours through the jejunum and ileum where maximal absorption of drugs and food occurs. Comparatively, the transit time in the colon varies from 7 to 20 hours.

Rectum is the terminal portion of the large intestine and functions for storage of the feces, the wastes of the digestive tract, until these are eliminated. The external opening at the end of the rectum is called the anus [1].

The significance of intestinal probiotics

The intestine is densely populated with bacteria, making it an important site for host-microbe interactions. Although a lot of research has mainly focused on intestinal pathogens that can cause localized and systemic infections, many intestinal microflora are not harmful, but, instead, are beneficial to the host [2]. These microflora that are beneficial to the host are known as the Lactic acid bacteria. Lactic acid bacteria are also called probiotics. Probiotic are used as health adjuncts to provide a wide variety of health benefits [3]. The two main types of bacteria that are known as Probiotics are Lactobacilli and bifidobacteria. The list of beneficial functions attributed to intestinal bacteria continues to grow and includes regulation of intestinal angiogenesis [4], nutrient processing [5], development of gut-associated lymphoid tissues [GALT] [6], induction of mucosal immunity [7], oral tolerance [8], and diversification of the preimmune Ab repertoire [9,10] in their studies have indicated that the lack of proper connections between human host and the bacteria contributes to the prevalence of allergies and Crohn’s disease in developed countries [11] have indicated that these intestinal microflora has been shown to contribute to antigenic exclusion. The resident microflora [probiotics] prevents adherence of disease-causing antigens by competing for nutrients and adhesion sites in the Gastrointestinal Tract [GUT], by producing antimicrobial agents, and by increasing production of specific antibody secreting cells and mucus. In another study, [12] have shown that when Lactobacillus GG was administered orally, it has the potential to increase the gut IgA immune response and thus promote the but immunological barrier. Consequently, Lactobacillus GG could provide an adjunct nutritional therapy for Crohn’s disease.

It was reported that oral administration of Lactobacillus sp. improved the antibody production to IFV vaccine applied subcutaneously [13]. It was also noted that the oral administration of Lactobacillus casei subsp. increased the anti-salmonella IgA level and as a result repressed the growth of Salmonella [14]. It was also stated that oral administration of Lactobacillus GG decreased atopic dermatitis [15].

Dietary intervention is a non-invasive and an attractive means of enhancing and optimizing important physiological functions, including the functioning of the immune system [16]. The capacity of dietary supplementation to improve immune function is seen as particularly important among certain groups of individuals. These individuals include those who may have a poorly functioning or underdeveloped immune system, such as infants, immunocompromised subjects and the elderly [17,18]. Health parameters, such as capacity to yield defensive responses and the capacity to fight secondary microbial infections to novel foreign material are impacted adversely by a sub optimally functioning immune system [e.g., in tumor control] [19]. There is an increasing indication that dietary consumption of fermented foods can improve certain key immune responses that are important in the maintenance of health [20,21]. In particular, there are a limited well-defined strain of lactic acid bacteria [LAB] which have been shown to improve immunity following dietary consumption, by acting as probiotics [22] thus suggesting that probiotics may be an effective means of disease prevention.

Some studies using individual LAB species, yogurt, or both exhibited promising health benefits for certain gastrointestinal conditions, including constipation, lactose intolerance, colon cancer, diarrheal diseases, Helicobacter pylori infection, inflammatory bowel disease, and allergies. Patients with any of these conditions could possibly benefit by ingesting yogurt.

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