Diet and the Microbiome

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New findings in the field of human microbiome research have the potential to change how we prevent, diagnose and treat illness. Genetic sequencing and the Human Microbiome and Metagenomics of the Human Intestinal Tract (MetaHIT) Projects have given us specific language and tools to dig deeper into the classification and functionality of the thousands of microbial species that reside within our bodies.

Of course, more work needs to be done regarding practical and clinical applications in enhancing health and treating disease. Part of the challenge lies in identifying and maximizing the dietary, environmental and other factors that contribute to a healthy microbiome, and in turn, how to influence our microbiomes for specific health outcomes. But what we do know so far is shedding important light on these relationships and points the way to a more sophisticated model of integrative health care -- one that harnesses the power of our friendly bacteria to support numerous areas of health.

We know that our microbiome has far reaching impact on immune health, inflammation, genetic expression, cellular signaling, neuro-hormone production, and the synthesis of essential nutrients and cofactors. We also know that certain foods and other components act as fuel for specific microbiota species. For example, dietary changes have been shown in a number of studies to alter the microbial composition of human fecal samples.[1] These findings explain the underlying differences in microbiota species observed among populations with different dietary habits (*e.g.,* standard Western, fiber-rich plant-based, vegetarian).

Vitamin Synthesis

The evolving data on the genetic capabilities of specific bacteria to biosynthesize vitamins and nutrients holds promise for individualized nutritional interventions. B vitamins (including biotin, cobalamin, folates, nicotinic acid, pantothenic acid, riboflavin and thiamine) as well as vitamin K can be synthesized by certain bacteria such as *Bifidobacterium* (of which at least 39 species have been found). These microbial metabolites constitute an important, naturally-derived source of these nutrients, depending on which strain is present. Genetic analysis has identified high-folate producing strains such as *Bifidobacterium bifidum* and *Bifidobacterium longum infantis* and low-folate producing strains such as *Bifidobacterium breve* and *Bifidobacterium adolescentis.*[2]

Some *Bifidobacteria* species are also found to convert certain dietary compounds into bioactive molecules such as conjugated linoleic acid. Probiotic microorganisms in cultured foods can also synthesize B vitamins and provide another important source of essential vitamins within the emerging "functional foods" or "medical foods" categories.[2]

Polyphenol Metabolism

There is also emerging evidence showing complex interactions between polyphenols from fruits and vegetables, and colonic microbiota. These polyphenol compounds are metabolized by microbiota enzymes and form complex metabolites that influence cell signaling, genetic expression and other functions. Studies also demonstrate alterations in gut microbiota from certain dietary polyphenols.[3] For instance, flavonols found in cocoa are shown to increase *Bifidobacteria* and *lactobacilli* populations, resulting in reduced triglycerides and C-reactive protein in human plasma samples.[4] Previously, it was believed that bioavailability and antioxidant capacity of polyphenols was limited; however, emerging research in this area helps further our understanding of the pharmacokinetics and mechanisms of these important phytonutrients.[5]

Dietary Influences

Most of the enzymes needed to break down carbohydrates are not part of mammalian genomes; instead they're provided by intestinal microbiota. In general, carbohydrates are the preferred energy source for most bacteria, though proteins can also be utilized. Carbohydrate fermentation by microbiota can result in the production of short chain fatty acids (SCFAs), depending on the type of bacteria. For example, *Furmicutes* bacteria produce SCFAs such as butyrate, which in turn promotes healthy cell differentiation and gut health. Decreased butyrate-producing bacteria in the gut is associated with Crohn's disease.[6]

The microbial metabolism of fiber phytochemicals is associated with reduced incidence of several chronic diseases. A groundbreaking study compared the fecal microbiota of a group of African children who ate a fiber-rich, plant-based diet, with the microbiota of a group of Italian children on a standard Western diet. The African group had lower levels of phylum *Firmicutes* and higher levels of bacteria in the *Bacteroidetes* phylum, specifically *Prevotella* and *Xylanibacter*. The Italian group had higher levels of *Enterobacteriaceae*. This is significant because *Prevotella* and *Xylanibacter* are associated with increased levels of SCFAs and protection against inflammation and infectious diseases. Other studies have shown that a vegetarian diet is associated with increased production of SCFA by gut microbes and reduced intestinal pH as well as protection against pathogenic bacteria, such as *E. coli.*[1, 7]

Diet-driven changes in microbiota composition and function help substantiate previous research on the protective value of dietary fibers in reducing the incidence of inflammatory diseases, particularly in the gastrointestinal tract.

Future Applications

Future recommendations for probiotic and prebiotic supplementation along with dietary interventions are likely to be highly individualized based on a person's unique microbial makeup. New diagnostic assays may utilize the species composition of an individual's microbiota, along with other potential risk factors, to aid in the screening, diagnosis and prognosis of various illnesses. As research in this field continues, stay tuned for exciting discoveries that will expand our understanding of bacterial commensals and their countless roles in health and disease.

References

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