The role of **probiotics** in the **gut**

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The human body is colonised by trillions of microbes which include bacteria, viruses and fungi. The term microbiome includes the genetic material of all the microbes that live on and inside the human body. It is estimated that the human microbiome may weigh approximately two kilograms. The majority of the microbes live in the gut, primarily in the large intestine and are referred to as the gut microbiome. The bacteria in the gut microbiome aid digestion, regulate the immune system, protect against other bacteria that cause disease (pathogenic bacteria) and may be involved in producing vitamins.

Each individual has a distinctive pattern of microbes determined partly by their genetics and initial microbial colonisation of the gut at birth (colonisation of the gastrointestinal tract of newborn infants starts immediately after birth and occurs within a few days). *Bifidobacteria* are one of the first bacteria to grow in the gut of a baby, which digests the healthy sugars in breast milk that are important for growth. In the early stages of the gut microbiome, breastfeeding plays an important role. Children who are breastfed for at least six months have more beneficial *Bifidobacteria* than those who are bottle-fed. Other factors that determine an individual's unique microbiome include age, gender, health/disease conditions, socio-economic factors (e.g. urban or rural, sanitation) and diet.

The gut microbiome and health

A hot topic in medical research has been the role of the microbiome on human health and is linked as being essential for human development, immunity and nutrition. The intestine is the largest immune organ in the body, providing an important interface between the human body and the microbes that enter from the external environment. The gut, therefore, has an important role in the body's immune system. In order for the intestine to function optimally, a balanced gut microbiome is necessary to communicate with immune cells and influence the way the body responds to infection. Recent research suggests that the gut microbiome may also influence brain health by producing brain chemicals and communicating with nerves that connect to the brain.

The gut microbiome is a complex ecosystem that normally exists in harmony with its human host. When this harmony is disrupted, known as dysbiosis, an imbalance of the gut bacteria occurs, and disease may follow. The disruption of the gut microbiome in babies and adults may contribute to gastrointestinal disorders and infections. Dysbiosis may also contribute to conditions such as diabetes, obesity and autoimmune diseases.

Modern lifestyles and increased stress levels challenge the immune system, which may disrupt the balance of the gut microbiome. Furthermore, while antibiotics play an important role in protecting against harmful bacterial diseases, extensive use of antibiotics may also negatively impact human health. Antibiotics are intentionally administered to kill pathogenic (harmful or bad) bacteria. However, broad-spectrum antibiotics are also likely to kill off the good bacteria in the body. A growing number of studies have shown that antibiotics can result in dysbiosis.

The role of probiotics

The role of bacteria in the human body has been studied extensively and identified as a means to improve health and prevent disease by balancing the gut microbiome using living microbial adjuncts, known as probiotics.

Probiotics are live microorganisms that, when administered in adequate amounts, are intended to confer health benefits on the host. The use of probiotics has become increasingly popular in recent years. The most common probiotics are bacteria that belong to groups called *Lactobacillus* and *Bifidobacterium*. Yeasts such as *Saccharomyces boulardii* may also be used as probiotics.

Probiotics are used to restore microbial balance and in order for them to 'work', they must have certain characteristics, such as being able to withstand passage through the gastrointestinal tract (survive stomach acid and bile degradation), colonise and reproduce in the

gut, attach and adhere to the intestinal epithelium and stabilise the balance of the gut microbiota.

Although the exact way in which probiotics are beneficial to humans has not been confirmed, it is thought they benefit the gut in the following ways:

- Competing with harmful microbes in the gut for nutrients, thereby preventing harmful microbes from growing
- Producing growth inhibitors
- Influencing intestinal immunity by stimulating the immune response

Much of the 'hype' surrounding probiotics may be due to the growing interest in the role of probiotics on overall health, in particular through the evolving understanding of the human microbiome. Studies have shown that probiotics have a role in the prevention and treatment of gastrointestinal conditions.

Diarrhoea in babies

Several studies have highlighted the ability of different probiotics, including various *Lactobacilli* and *Bifidobacteria* species, to reduce the duration of rotavirus and watery diarrhoea. Oral administration of these probiotics has been shown to shorten the duration of acute diarrhoeal illness by approximately one day.

Antibiotic-associated diarrhoea

Antibiotic-associated diarrhoea (AAD) is a side-effect frequently associated with the use of broad-spectrum antibiotics. AAD occurs when the antibiotic disrupts the ecology of the intestinal microbiome, by altering the diversity and numbers of bacteria in the gut and causing the excessive growth of normally harmless bacteria.

Probiotic bacteria such as *B. longum* and *Lactobacillus rhamnosus GG* and the yeast *Saccharomyces boulardii* have been found to have beneficial effects on the prevention and/or incidence of AAD.

Travellers' diarrhoea

Infectious gastroenteritis often occurs in travellers. A number of studies have assessed the potential of probiotics to prevent travellers' diarrhoea, with varying results depending on the species used, vehicle and the dosage schedule. Benefits have been reported particularly with *Lactobacillus GG* and *B. bifidum*.

Infant colic

Colic is excessive, unexplained crying in young infants. Babies with colic may cry for three hours or more a day, but they eat well and grow normally. The cause of colic is not well understood, but studies have shown differences in the microbial community in the digestive tract between infants who have colic and those who do not, which suggests that the gut microbiome plays a role. The probiotic *Lactobacillus reuteri* has been associated with successful treatment (defined as a reduction of more than half in daily crying time). This effect was mainly seen in exclusively breastfed infants.

Safety aspects of probiotics

Probiotics must remain viable for the entire shelf-life of the product and not have any pathogenic properties. The 2016 Complementary Medicines – Health Supplements Safety and Efficacy guideline requires probiotic supplements to contain at least 1 x 10^9 colony forming units (CFUs) per dosage unit. Not all commercially available products have been found to contain the probiotic strains listed on the label, and in some cases, the bacteria may not be viable.

Probiotics have an extensive history of being well-tolerated, particularly in healthy people. However, only a few studies have looked at the safety of probiotics in detail. Therefore, there is a lack of robust data on safety. The risk of harmful effects from probiotics is greater in people with severe illnesses or with compromised immune systems. When probiotics are being considered for high-risk individuals, such as premature infants or seriously ill hospitalised patients, the potential risks of probiotics should be carefully weighed against their benefits. Probiotics' possible harmful effects include increased risk of infections, production of harmful substances by the probiotic microorganisms, and transfer of antibiotic resistance genes from probiotic microorganisms to other microorganisms in the digestive tract. Some probiotic products have been reported to contain microorganisms other than those listed on the label. In some instances, these contaminants may pose serious health risks.

Conclusion

Research has identified that a balanced gut microbiome is key to gastrointestinal health, the immune system and other health aspects. Probiotics offer a dietary means to support and maintain the gut microbiome. Important to note is that the effect of probiotics is strain-specific and generalisation about the potential health benefits cannot be assumed across all strains. Each probiotic strain needs to be assessed on its own in controlled studies before specific claims are made. While probiotics are widely used in healthy individuals, there are potential risks when used in severely ill and immunocompromised patients.

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