Probiotics and Metabolic Pathways: Unraveling improvement of metabolic pathways

Paula Arango

Thompson Rivers University

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Dr. Punnet Arora

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An estimated 21.7 million individuals are hospitalized each year due to digestive illnesses, according to the National Institute of Diabetes and Digestive and Kidney diseases. A person's gut health opens the door to a happier, healthier, and more fulfilling life. Abdominal discomfort can be caused by a variety of things, including digestive issues, injuries, infections, or illnesses. This paper will discuss the importance of prioritizing gut health to support overall well-being and the potential of probiotics as a promising strategy to optimize metabolic pathways and promote a healthier gut environment by highlighting the intricate connections such as gut health, the gut microbiota, and the metabolism of lipids and amino acids. Uncovering the potential health advantages of probiotic supplements in preserving gut health depends on an understanding of these interactions.

To begin, the primary function of the gut is to digest the food we consume and absorb all the nutrients and critical chemicals required for everyday activity. The microbiome is the ecosystem that a variety of beneficial bacteria make habitat in the gut. The gut microbiota is a “consortium of microorganisms (bacteria, archaea, fungi, protozoa and viruses” (Ryšávka et al., 2022) Some of these bacteria include Lactobacillus, Bacteroides and Bifidobacterium. A healthy gut should have a large population of beneficial bacteria that outweigh harmful ones. The metabolism of lipids and amino acids are essential for cellular structure, energy storage, and a number of biological activities, are the guts’ important roles. Moreover, In order to support the development of specialized microorganisms that create short chain fatty acids (SCFAs) microbiota facilitate the fermentation of indigestible substrates. Acetate, propionate, and

butyrate are the main SCFAs generated. This offers energy sources, consistent oxygen balance, and dysbiosis avoidance (Valdes et al,. 2018) Changes in the gut microbiota have been linked to a variety of chronic illnesses, including inflammatory bowel disease (IBD), irritable bowel syndrome (IBS), obesity, metabolic syndrome and many more.

Physiological similarity to the gut, probiotics are living bacteria that, when given to a host in sufficient quantities, have positive benefits on their health. These microbes, mostly bacteria but also include yeasts, have drawn a lot of attention from researchers and the general public in recent years due to their potential to improve gut health. In order to understand probiotics' complicated interactions with the gastrointestinal system and their potential uses in preserving a healthy gut microbiota, it is crucial to comprehend what probiotics are and how they work. When an individual takes probiotics as a dietary supplement, it generally appears like a tablet with powder inside that contains the probiotics. This might have been accomplished via freeze-drying at temperatures ranging from -40 to -70°C, or less, along with water evaporation to render bacteria inactive, or by lyophilization. "The combination of low temperature and acidity is effective in maintaining probiotics in a dormant state [then] the probiotic bacteria continue their voyage after passing through the stomach” (Vinderola, 2020). . They are discharged into the small intestines, where certain strains may inhabit for a brief period of time. Other strains may get through the small intestine and establish themselves in the large intestine .

Probiotics, particularly those capable of generating SCFAs such as butyrate, are critical in boosting fatty acid oxidation. Butyrate has been shown to increase the

expression of genes and enzymes involved in fatty acid beta-oxidation, most notably in liver and adipose tissue (Markowiak-Kopeć et al., 2020). This mechanism promotes the breakdown of lipids into energy, resulting in less lipid buildup within tissues and, as a result, lower circulating triglyceride levels. Probiotics' regulation of fatty acid oxidation is a potential approach to addressing dyslipidemia and its related metabolic problems. Another important component of probiotics' influence on lipid metabolism is lipogenesis suppression. Lipogenesis is the metabolic process in which fatty acids are synthesized and stored as triglycerides in the liver and adipose tissue. Probiotics work by lowering the creation of new triglycerides by downregulating the expression of genes linked with lipogenesis. This inhibition avoids excessive fat accumulation and lowers circulating levels of dangerous triglycerides, which contributes to healthier lipid profiles and a lower susceptibility to dyslipidemia-related health hazards (Kersten, 2001). Furthermore, through improving lipid metabolism and reducing circulating triglycerides, probiotics help to reduce systemic inflammation, which is a common denominator in many gut-related illnesses.

To delve deeper, clinical trials are key to confirm the statement of this paper. A clinical trial that is worth noting, is the treatment of irritable bowel syndrome patients. According to the research findings, a quantitative stool analysis has the potential to improve the efficacy of probiotic treatment and achieve a significant treatment success rate of 45% in patients who have persistent symptoms of irritable bowel syndrome (IBS) after a standard multispecies probiotic intervention. Notably, when patients with IBS were shown to have a deficit in Enterococcus which resulted in an amazing 83% of

patients becoming symptom-free (Rollinger-Holzinger et al., 2018). These findings underscore the possible role of customized probiotic medication, guided by stool microbiota investigation, in controlling IBS symptoms. Nonetheless, These studies will help to create evidence-based guidelines for using tailored probiotic therapy in the clinical context and also proves that probiotics open a gate to improvement of metabolic pathways.

In conclusion, this paper has highlighted the intricate interplay between probiotics, gut microbiota, impacting lipid absorption, metabolism, and transport, as well as the bioavailability of essential amino acids for protein synthesis and other biological processes. Probiotics have emerged as a promising avenue for promoting gut health by modulating microbiota composition and function, offering new perspectives for metabolic disorder management. By enhancing microbial balance and bolstering the guts' barrier function, probiotics contribute to creating a thriving gut environment that fosters optimal nutrient absorption and immune regulation. As we deepen our understanding of the intricate connections between probiotics, gut microbiota, and metabolic pathways, we can develop targeted and innovative strategies to optimize gut health and foster a healthier future for individuals worldwide.

References

Blatchford, P., Ansell, J., de Godoy, M. R. C., Fahey, G., Garcia-Mazcorro, J. F., Gibson, G. R., Goh, Y. J., Hotchkiss, A. T., Hutkins, R., LaCroix, C., Rastall, R. A., Reimer, R. A., Schoterman, M., Van Sinderen, D., Venema, K., & Whelan, K. (2013). Prebiotic Mechanisms, Functions and Applications - a Review. *International Journal of Probiotics & Prebiotics*, *8*(4), 109–131.

Gabriel Vinderola. (2020). *How do probiotics stay alive until they are consumed?*. International Scientific Association for Probiotics and Prebiotics. https://isappscience.org/how-do-probiotics-stay-alive-until-they-are-consumed/

Irokanulo, E. O., & Akalegbere, M. A. (2020). Probiotics for Gastrointestinal Health and General Wellbeing. *International Journal of Probiotics & Prebiotics*, *15*(1), 22–29. https://doi-org.ezproxy.tru.ca/10.37290/ijpp2641-7197.15

Kersten, S. (2001). Mechanisms of nutritional and hormonal regulation of lipogenesis. EMBO reports, 2: 282-286. https://doi.org/10.1093/embo-reports/kve071

Lih-Ren Kong, Hsin-Ya Lin, Min-Shan Hsiao, & Shu-Ching Wang. (2022). Synbiotic Supplementation Facilitates Weight Loss, Improves Lipid Profile and Gut Health in Overweight and Obese Subjects. *International Journal of Probiotics & Prebiotics*, *17*(1), 53–59. https://doi-org.ezproxy.tru.ca/10.37290/ijpp2641-7197.17:53-59

Markowiak-Kopeć, P., & Śliżewska, K. (2020). The Effect of Probiotics on the Production of Short-Chain Fatty Acids by Human Intestinal Microbiome. *Nutrients*, *12*(4), 1107. MDPI AG. Retrieved from http://dx.doi.org/10.3390/nu12041107

Paek, J., Kang, B. C., Yang, H., & Lee, Y. (2022). Binding to Intestinal Epithelial Cells and Anti-Inflammatory Activity of Lactobacillus fermentum PL9988. *International Journal of Probiotics & Prebiotics*, *17*(1), 14–20. https://doi-org.ezproxy.tru.ca/10.37290/ijpp2641-7197.17:14-20

Rollinger-Holzinger, I., Seimetz, M., Bocquet, V., & Weber, B. (2018). Optimization of a Probiotic Therapy in Patients with Irritable Bowel Syndrome under Real Life Conditions. An Observational Study. *International Journal of Probiotics & Prebiotics*, *13*(4), 127–137.

Ryšávka, P., Kohutková-Lánová, M., Netušil, R., Pospíšilová, E., Hanáčková, M., Čmielová, J., Šťastný, K., Márová, I., Haranta, M., & Bomba, A. (2022). Targeted Modulation of Gut Microbiota by Personalized Probiotics. *International Journal of Probiotics & Prebiotics*, *17*(1), 33–41. https://doi-org.ezproxy.tru.ca/10.37290/ijpp2641-7197.17:33-41

Sajid, M., & Negi, S. (2020). Gut Microbes: A Plausible Association Between Inflammaging and Metabolic Disorders. *International Journal of Probiotics & Prebiotics*, *15*(1), 34–44. https://doi-org.ezproxy.tru.ca/10.37290/ijpp2641-7197.15:34-44

U.S. Department of Health and Human Services. (n.d.). *Digestive diseases statistics for the United States - NIDDK*. National Institute of Diabetes and Digestive and Kidney Diseases.https://www.niddk.nih.gov/health-information/health-statistics/digestive-diseases

Valdes A M, Walter J, Segal E, Spector T D. (2018). Role of the gut microbiota in nutrition and health. *BMJ* . 361 :k2179 doi:10.1136/bmj.k2179