PREBIOTICS AND POSTBIOTICS

Parvati Sajjan, Sushma N H, Nachiket Phatak, P Pallavi
Department of Biotechnology, R V College of engineering, Bangalore, India.

Corresponding author:
Dr S Narendra Kumar, Department of Biotechnology,
R V College of engineering, Bangalore, India.

Abstract:

The phrases "prebiotics" and "postbiotics" are used to refer to various gut microbiota-related elements and outcomes. Prebiotics are certain dietary fibres that can withstand digestion and act as a food supply for good bacteria in the colon. They are not degraded by stomach acid or mammalian enzymes, and they pass through the digestive system undigested. The idea of prebiotics was first proposed in the early 1900s when scientists discovered that probiotic microorganisms produced advantageous substances through the fermentation process. Postbiotics, on the other hand, are the leftovers from microbial metabolism or the deactivated parts of bacteria. They can consist of a variety of compounds, including lactic acid, bacteriocins, and teichoic acids. Antibiotics may Postbiotics can directly affect the host, affecting a variety of biological functions. Postbiotics have an immediate effect on the host, whereas prebiotics primarily act as food for good bacteria. They may have antibacterial traits that prevent the development of harmful microorganisms and dislodge biofilms. Postbiotics may also affect the general health of the gut by altering the gut flora. Although "postbiotics" became a common name in the late 20th century, the basic idea and study findings date back further. As a result, prebiotics and postbiotics are separate substances with discrete functions in the gut flora. Prebiotics and postbiotics both participate in the intricate and dynamic interactions that take place inside the gut environment, which have an impact on general health and wellbeing.

Keywords: Probiotics, postbiotics, gut microbiota, gastrointestinal disorders, gastrointestinal tract.

Introduction:

According to ISAPP, a prebiotic is a substance "selectively utilised by host microorganisms conferring a health benefit." Prebiotics, sometimes referred to as "functional fibre," are nondigestible carbohydrates found in food. The ISAPP defines postbiotics as "a preparation of inanimate microorganisms and/or their components that confers a health benefit" in contrast to prebiotics. Postbiotics may be fully developed microorganisms or inactivated bacteria or bacteria fragments. The concept of prebiotics was initially introduced by Glenn Gibson and Marcel Roberfroid in 1995. Bacteriocins, which are antimicrobial substances produced by certain bacteria, were first discovered in the 1920s, and their existence shed light on the potential therapeutic benefits of postbiotics. Prebiotics can take many different shapes. Like fructans, galacto-oligosaccharides, oligosaccharides derived from starch and glucose, other oligosaccharides, and non-carbohydrate oligosaccharides.

Production method and mechanism of Prebiotics and Postbiotics:

Prebiotics are vital for maintaining human health. Seaweeds and microalgae also contain them naturally, as do asparagus, sugar beets, garlic, chicory, onions, Jerusalem artichokes, wheat, honey, bananas, barley, tomatoes, rye, soybeans, peas, and other dietary items. On an industrial scale, the bulk of prebiotics fall within the GOS and FOS categories.

i. **FOS:** Although it is present in around 36,000 plants, these sources do not contain enough FOS to have prebiotic effects. Glycosidase and glycosyl-transferase can be used to chemically synthesise FOS. Glycosidase and glycosyl-transferase can be used to chemically synthesise FOS. By transferring one to three fructose molecules from sucrose, FTase produces FOS. The initial sucrose concentration (theoretically about 55–60%) determines the maximum amount of FOS that FTases may produce. The fermentation byproduct glucose prevents trans-glycosylation. The removal of glucose and sucrose residues is therefore a crucial step in raising FOS fermentation yields.

ii. **GOS:** Nucleophilic and electrophilic displacement was first used to chemically synthesise GOSs, however this method is currently deemed uneconomical on an industrial scale. Galactosidase and galactosyl-transferase are the enzymes that create GOS. A stereoselective enzyme called galactosyl-transferase may produce a lot of GOS.Increases in donor and acceptor concentration, a decrease in the reaction's water activity, and other factors can all increase the quantity of GOS that galactosidase

produces. Eliminating the product in the medium causes the reaction equilibrium to shift in the direction of the end product. and adjusting the synthesis parameters.

Numerous species, such as Aspergillus oryzae, Sterigmatomyces elviae, Bifidobacteria, and Lactobacilli, include BETA-Galactosidases. variable -galactosidases from various sources result in various kinds of GOS with variable quantities of DP and glycosidic linkages.

The suitable probiotic strain is initially added to an inoculum tank bioreactor (IT-01) that is small-scale (1 to 10 L) and used for Postbiotics. The probiotic cells are transferred to a larger scale bioreactor (above 10 L), frequently a stirring tank reactor that runs in batches without aeration, after early development and establishment of the exponential phase. Both Lactobacillus and Saccharomyces flourish in anaerobic circumstances. The fermentation broth is taken out of the bioreactor after the biomass concentration is appropriate, and it can then go through one of three postbiotic downstream processes:

1. Conventional biomass removal,
2. Direct cell lysis, followed by the removal of cell debris and the extraction of secondary metabolites produced from probiotics.
3. The centrifuge (C-01), used in the typical postbiotic production procedure, separates the biomass from the cell-free supernatant.
4. Before entering a homogenizing tank (HT-01), the supernatant is filtered (F-01) with a rotating drum filter.

Prebiotics work by altering the gut microbiota, which benefits the immune system, nervous system, skin, and calcium absorption as well as maintaining good health and warding off diseases including irritable bowel syndrome, Crohn's disease, colorectal cancer, and necrotizing enterocolitis. While the processes of postbiotics entail strengthening the epithelial barrier, modifying immune responses, and protecting against pathogens.

Interpretations and Discussions:

Advantages of Postbiotics Compared with Probiotics:

The use of non-viable postbiotics as a safer alternative has gained popularity as safety concerns concerning the use of live strains in particular patient populations, including as immunocompromised individuals, infants, and delicate patients, have surfaced. They might significantly reduce the risk of microbial translocation and consumer sickness.

It will be difficult to determine the proportion of viable dead cells in a probiotic culture. As a result, varying percentages of dead cells may be to blame for the variations in reactivity seen with live probiotic supplementation. On the other hand, postbiotics may be simply proven to be devoid of any living things. Products based on postbiotics would be durable and very easy to standardise, making them easier to store, have a longer shelf life, and, most importantly, be more reliable.

By lessening the likelihood of the transmission of genes causing antibiotic resistance, using inactivated bacteria can have significant advantages. Probiotics are now being investigated in terms of antimicrobial resistance prevention strategies and the need to avoid prolonged pharmaceutical treatments and their negative effects. The use of non-viable probiotics as an alternative treatment is growing in popularity due to the increasing incidence of antibiotic resistance in live probiotic applications.

Applications of Prebiotics:

i. **In the food industry:**In the food business, they significantly improve meals' flavour and texture by strengthening organoleptic qualities. Research examined the impact of commercial prebiotic processing factors on prebiotic activity using a prebiotic activity test.As a possible source of prebiotics and probiotics, dairy products are being employed more frequently to create synbiotic diets..

ii. **In health:** For health: Numerous microbe species that coexist with the host in a symbiotic manner reside in the human gut. Dysbiosis, or the disruption of microbial equilibrium, of intestinal bacteria can be detrimental to health and result in the development of allergies, irritable bowel syndrome,

depression, autism, and other disorders (Joshi, Roy, & Banerjee, 2018). Therefore, consuming prebiotics may indicate that one's health has improved.

iii. Applications of Postbiotics:

i. **In food industry:** The most common process with postbiotic usage is fermentation, and producer strains of Lactobacillus and Bifidobacterium are frequently used. The dairy industry gains a lot from the EPS of certain strains of dairy starter cultures since it has a significant impact on the rheological characteristics of fermented dairy products and reduces their moisture content. To extend the shelf life of soybeans, Lactobacillus plantarum postbiotics can be utilised as a biopreservative.

ii. **In pharmaceuticals:** Numerous postbiotics products that are currently in the experimental stage and have not yet undergone clinical testing have a wide range of potential applications. The biosurfactants of L. gasseri have been shown to have antibiofilm capability against methicillin-resistant S. aureus (MRSA) in 2019, according to Giordani B et al. Another illustration is the heat-stabilized acidophilus-containing medication Lacteól Fort (Laboratoire du Lacteól du docteur Boucard, France), which has been found in randomised controlled trials to be effective in the treatment of acute diarrhoea and irritable bowel syndrome (IBS).

iii. **In Biomedical:**It has been demonstrated that postbiotics enhance the advantages of vaccination in the elderly; the underlying mechanism involves persistent antibody formation and NK-cell activation. In 2016, it was shown that a subset of older people had higher levels of antibodies against type A/H1N1 and type B antigens when given heat-killed Lactobacillus paracasei jelly. Postbiotics, like parent probiotics, have both immunomodulatory and antibacterial activities, making them a possible treatment for paediatric infectious diseases in children under the age of five.

Future scope of Prebiotics and Postbiotics:

The market's top companies are attempting to meet the growing demand for healthy food items by funding postbiotics research and development initiatives. As a result, the market for postbiotics products is growing. Postbiotics have been shown in recent research to significantly improve symptoms of acute diarrhea, allergic

responses, immunological function, and neurodegenerative illnesses including Alzheimer's, Parkinson's, multiple system atrophy, among others, with few to no adverse effects.

Conclusion:

Prebiotics have demonstrated positive impacts on human health, however further studies are required to support these claims and comprehend the underlying processes. Scientists can create superior dietary supplements by comprehending the fundamental workings of prebiotics. The normalization of the gut microbiota by prebiotics is essential for the treatment of illnesses. Prebiotics are simpler to make and store than probiotics and have fewer side effects. Postbiotics have advantageous effects on the host, although it is unclear how they work exactly. For characterisation and stability, more investigation is required.

References

[1] R. M. Patel and P. W. Denning, “Therapeutic Use of Prebiotics, Probiotics, and Postbiotics to Prevent Necrotizing Enterocolitis,” Clinics in Perinatology, vol. 40, no. 1, pp. 11–25, Mar. 2013, doi: 10.1016/j.clp.2012.12.002.

[2] R. R. M. Rd, “What Are Postbiotics? A Comprehensive Overview,” Healthline, May 19, 2021. https://www.healthline.com/nutrition/postbiotics

[3] G. Vinderola, M. E. Sanders, and S. Salminen, “The Concept of Postbiotics,” Foods, vol. 11, no. 8, p. 1077, Apr. 2022, doi: 10.3390/foods11081077.

[4] Boehm G., Lidestri M., Casetta P., Jelinek J., Negretti F., Stahl B., Marini A. Supplementation of a bovine milk formula with an oligosaccharide mixture increases counts of faecal bifidobacteria in preterm infants. Arch. Dis. Childhood-Fetal Neonatal Ed. 2002;86:F178–F181. doi: 10.1136/fn.86.3.F178.

[5] Indrio F., Riezzo G., Raimondi F., Francavilla R., Montagna O., Valenzano M.L., Cavallo L., Boehm G. Prebiotics improve gastric motility and gastric electrical activity in preterm newborns. J. Pediatr. Gastroenterol. Nutr. 2009;49:258–261. doi: 10.1097/MPG.0b013e3181926aec.

[6] Maiorano A.E., Piccoli R.M., Da Silva E.S., de Andrade Rodrigues M.F. Microbial production of fructosyltransferases for synthesis of pre-biotics. Biotechnol. Lett. 2008;30:1867–1877. doi: 10.1007/s10529-008-9793-3.

[7] E. Scarpellini et al., "From Pre- and Probiotics to Post-Biotics: A Narrative Review," International Journal of Environmental Research and Public Health, vol. 19, no. 1, p. 37, Dec. 2021, doi: 10.3390/ijerph19010037.

[8] J. Żółkiewicz, A. Marzec, M. Ruszczyński, and W. Feleszko, "Postbiotics—A Step Beyond Pre- and Probiotics," Nutrients, vol. 12, no. 8, p. 2189, Jul. 2020, doi: 10.3390/nu12082189.

[9] B. Liang and D. Xing, "The Current and Future Perspectives of Postbiotics," Probiotics and Antimicrobial Proteins, Feb. 2023, doi: 10.1007/s12602-023-10045-x.

[10] Y. Bourebaba, K. Marycz, M. Mularczyk, and L. Bourebaba, "Postbiotics as potential new therapeutic agents for metabolic disorders management," Biomedicine & Pharmacotherapy, vol. 153, p. 113138, Sep. 2022, doi: 10.1016/j.biopha.2022.113138.

[11] O'Brien, M.T.; O'Sullivan, O.; Claesson, M.J.; Cotter, P.D. The Athlete Gut Microbiome and Its Relevance to Health and Performance: A Review. Sports Med. 2022, 52, 119–128.

[12] Hooks, K.B.; O'Malley, M.A. Contrasting Strategies: Human Eukaryotic versus Bacterial Microbiome Research. J. Eukaryot. Microbiol. 2020, 67, 279–295.

[13] Zheng, D.; Liwinski, T.; Elinav, E. Interaction between Microbiota and Immunity in Health and Disease. Cell Res. 2020,

[14] A. Da Silva Vale et al., "Production, Formulation, and Application of Postbiotics in the Treatment of Skin Conditions," Fermentation, vol. 9, no. 3, p. 264, Mar. 2023, doi: 10.3390/fermentation9030264.

[15] K. G. RDN, "Prebiotics vs. Probiotics vs. Postbiotics: What's The Difference?," Forbes Health, Jun. 13, 2023. [Online]. Available: https://www.forbes.com/health/body/prebiotics-probiotics-postbiotics/

[16] Alexis Mosca, Ana Teresa Abreu Y Abreu, Kok Ann Gwee, Gianluca Ianiro, Jan Tack, Thi Viet Ha Nguyen & Colin Hill (2022) The clinical evidence for postbiotics as microbial therapeutics, Gut Microbes, 14:1, DOI: 10.1080/19490976.2022.2117508

[17] Malashree, L., Vishwanath Angadi, K. Shivalkar Yadav and Prabha, V. 2019. "Postbiotics" - One Step Ahead of Probiotics.Int.J.Curr.Microbiol.App.Sci. 8(1): 2049-2053. doi: https://doi.org/10.20546/ijcmas.2019.801.214

[18] K. Viswanathan, "Review on the Current Trends and Future Perspectives of Postbiotics for Developing Healthier Foods," Longdom, Aug. 2022, doi: 10.35248/2329-8901.22.10.286.

[19] F. Coleman, "Prebiotics, Probiotics, Postbiotics: What Are They And Why Do We Need Them?," Study Finds, May 11, 2023. [Online]. Available: https://studyfinds.org/prebiotics-probiotics-postbiotics/34.

[20] A. Da Silva Vale et al., "Production, Formulation, and Application of Postbiotics in the Treatment of Skin Conditions," Fermentation, vol. 9, no. 3, p. 264, Mar. 2023, doi: 10.3390/fermentation9030264.

[21] Vallejo-Cordoba B, Castro-López C, García HS, González-Córdova AF, Hernández-Mendoza A (2020) Postbiotics and paraprobiotics: a review of current evidence and emerging trends. Adv Food Nutr Res 94:1–34

[22] Salminen S, Collado MC, Endo A, Hill C, Lebeer S, Quigley EMM et al (2021) The International Scientific Association of Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of postbiotics. Nat Rev Gastroenterol Hepatol 18(9):649–667

[23] Wegh CAM, Schoterman MHC, Vaughan EE, Belzer C, Benninga MA (2017) The effect of fiber and prebiotics on children's gastrointestinal disorders and microbiome. Expert Rev Gastroenterol Hepatol 11(11):1031–1045

[24] Lebeer S, Vanderleyden J, De Keersmaecker SC (2010) Host interactions of probiotic bacterial surface molecules: comparison with commensals and pathogens. Nat Rev Microbiol 8(3):171–184