EC MICROBIOLOGY
Mini Review

Postbiotic Evolution in Dermatology

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Abstract

A growing amount of research reported the role of pre- and probiotics in promoting general health and treating human diseases including dermatological conditions. A new class of health-promoting molecules deriving from probiotics is that represented by postbiotics. As the results of microbial metabolism, postbiotics include peptides, enzymes, short-chain fatty acids (SCFAs), antimicrobial peptides (AMPs), endo- and exo-polysaccharides, cell surface proteins, vitamins, plasmalogens and organic acids. They are able to positively affect both the resident microbiota and host metabolic and signaling pathways. Nowadays they could represent an evolution in the use and capitalization of health-promoting effects deriving from microorganisms for human health.

Keywords: *Postbiotic; Probiotic; Microbiome; Dermatology; GABA; PlnA*

A growing amount of research reported evidence of the health-promoting effect of both prebiotics and probiotics [1-3]. They act primarily, by increasing levels of beneficial bacteria or, indirectly, by influencing the immune system which in turn influences the host microbiome.

A new open perspective in the field is that represented by “paraprobiotic”. They are non-viable microorganisms with the same probiotic activity and health benefits of the viable microrganism but safer than probiotics [4].

Another new class of health-promoting molecules derived from probiotics is represented by “postbiotics”. The term refers to soluble factors released by beneficial bacteria and they seem to be responsible for beneficial effects of probiotics [4]. As the results of microbial metabolism, they include peptides, enzymes, short-chain fatty acids (SCFAs), antimicrobial peptides (AMPs), polysaccharides, cell surface proteins, vitamins, plasmalogens, and organic acids [5]. The mechanisms implicated in their health benefits are not fully elucidated but a recent study reported different functional properties (e.g. antimicrobial, antioxidant and immunomodulatory) [4].

The main advantage of postbiotic’s use is represented by the easier way they have to interact with the microbiome and human cells as they do not need to grow and propagate as probiotics. They may have a direct therapeutic potential as they can be administered directly, also considering that they have a great absorption, metabolism, distribution and excretion potential [6]. Therefore, postbiotics possess a defined chemical structure and the dose parameters can be safely defined, they also can be safely administered to immune-deficient or compromised patients for which live probiotic bacteria are not allowed [7]. Finally, postbiotics usually possess a longer shelf-life than probiotics.

About 1000 postbiotics have been identified which mainly derived from *Lactobacillus* and *Bifidobacterium* strains as well as yeasts. They can be obtained as intracellular metabolites or cell wall components, either as mixtures extracts or suspensions from probiotic strains [8].

There is increasing evidence supporting the role of postbiotics in stimulating healthy gut microbiota and supporting immune function through the gut [9].

Fermented products can also improve gut health and it is now recognized that many of the health benefits of fermentation can be attributed to corresponding postbiotics. Indeed, during the fermentation of food by probiotics, production of postbiotics is enhanced. One example is the production of intestinal gamma-aminobutyric acid (GABA) [10].

Postbiotics are reported to exert other health-promoting effects beyond well-being of the gut including skin health (atopic eczema, atopic dermatitis, wound-healing, skin-rejuvenating, skin innate immunity and hair growth disorders such as alopecia areata).

Microorganisms inhabiting the skin play roles such as protecting its barrier functions, fighting pathogenic bacterial infections, maintaining pH, stimulating the production of antimicrobial peptides, and rising inflammation. The microbiome also protects skin from environmental stressors, such as free radicals, UV radiation, and pollution [11].

Postbiotics may also serve as "protection system". Among others, bacteria are able to produce substances/postbiotics implicated in skin health, such as hyaluronic acid, sphingomyelinase, lactic acid, acetic acid and diacetyl [12].

Fermentation by lactic acid bacteria is reported to increase GABA production. GABA can be obtained as an end product of *Lactobacillus plantarum* fermentation on grape must [13]. Its efficacy as postbiotic for dermatological application has been reported by Di Cagno and collaborators [13]. The study showed that GABA is effective in inducing the expression of HBD-2. Therefore, the GABA preparation also stimulated the synthesis of HAS-1, involved in the synthesis of hyaluronan [14] and FLG which is an important role in the barrier function of the skin [14].

Also, bacterial cell components such as lipoteichoic acid and peptidoglycan are reported to stimulate production of skin's natural antimicrobial peptides such as human β-defensins HBD and cathelicidins [12].

Most interesting, several lactic acid bacteria produce peptides with antimicrobial activity via quorum sensing. One example is Plantaricin A (PlnA), a bacteriocin produced by *L. plantarum* with antimicrobial and pheromone activities [16]. In our previous work [17] we showed the proliferative and wound-healing effect of PlnA on human NCTC 2544 keratinocytes and this activity resulted higher than hyaluronic acid. PlnA is also able to affect key mediators of proliferation, migration, and differentiation of epithelial cells such as transforming growth factor-β1 (TGF-β1), keratinocyte growth factor 7 (FGF7), vascular endothelial growth factor (VEGF-A), and interleukin-8 (IL-8) genes. In further work [18], we showed that PlnA is also able to intervene in antioxidant defense systems of skin and to improve skin barrier function by regulating the expression of FLG, involucrin (IVL), hyaluronan synthase (HAS2) and HBD-2 and tumor necrosis factor-alpha (TNF-a). Taking together these findings suggested that the postbiotic PlnA can be positively sensed by human keratinocytes, promoting not only proliferation and differentiation of epithelial cells but also promoting antioxidant defenses, barrier function and antimicrobial activity of the skin. The ongoing research is actually aiming to study the effect of PlnA effect on scalp dysbiosis in subjects affected by Alopecia areata [19].

The main role of the many postbiotics produced by microorganisms is antioxidant activity which makes them perfect candidates for both oral and dermatological use. In this sense, the fermentation of food matrices by probiotics strains can increase the production of bioactive [20-22], postbiotic-acting substances with health benefits on the gut and skin.

At last but not the least, postbiotics acting directly on the resident microbiome by stimulating beneficial microorganisms to produce health-promoting substances.

For the moment, postbiotics represent the best and safer alternatives to the use of live microorganisms [5,12]. The up-regulation of key genes involved in skin healthiness might open to a new therapeutic approach in cosmetics by microbial metabolites, including GABA.

Conclusion

In conclusion, the use of prebiotics probiotics and postbiotics represents a valid therapeutic approach both for improving the healthiness and coping with many diseases. Although both the use of prebiotics and probiotics and postbiotics presents its challenges, current evidence is suggesting that the use of postbiotic could represent an evolution in the use and capitalization of health-promoting effects derived from microorganisms for human health.

Bibliography

1. Ursell LK., *et al*. "Defining the human microbiome". *Nutrition Reviews* 70 .1 (2012): S38-S44.
2. Carabottia M., *et al*. "The gut-brain axis: interactions between enteric microbiota, central and enteric nervous systems". *Annals of Gastroenterology* 28 (2015): 203-209.
3. Markowiak P and Śliżewska K. "Effects of Probiotics, Prebiotics, and Synbiotics on Human Health". *Nutrients* 9.9 (2017): 1021.
4. Toalaa JE., *et al*. "Postbiotics: An evolving term within the functional foods field". *Trends in Food Science and Technology* 75 (2018): 105-114.
5. Tsilingiri K and Rescigno M. "Postbiotics: What else?" *Beneficial Microbes* 4.1 (2013): 101-107.
6. Shenderov BA. "Metabiotics: Novel idea or natural development of probiotic conception". *Microbial Ecology in Health and Disease* 24 (2013): 1-8.
7. Tsilingiri K., *et al*. "Probiotic and postbiotic activity in health and disease: Comparison on a novel polarized ex-vivo organ culture model". *Gut* 61 (2012): 1007-1015.
8. Trivedi B. "Microbiome: The surface brigade". *Nature* 492.7429 (2012): S60-S61.
9. Patel R and Denning P W. "Therapeutic Use of Prebiotics, Probiotics, and Postbiotics to Prevent Necrotizing Enterocolitis. What is the Current Evidence?" *Clinics in Perinatology* 40.1 (2013): 11-25.
10. Dhakal R., *et al*. "Production of gaba (γ - Aminobutyric acid) by microorganisms: a review". *Brazilian Journal of Microbiology* 43.4 (2012): 1230-1241.
11. Parrado C., *et al*. "Environmental Stressors on Skin Aging. Mechanistic Insights". *Frontiers in Pharmacology* 10 (2019): 759.
12. Lew LC and Liong MT. "Bioactives from probiotics for dermal health: functions and benefits". *Journal of Applied Microbiology* 114.5 (2013): 1241-1253.
13. Di Cagno R., *et al*. "Synthesis of gamma-aminobutyric acid (GABA) by Lactobacillus plantarum DSM19463: functional grape must beverage and dermatological applications". *Applied Microbiology and Biotechnology* 86.2 (2010): 731-741.
14. Stern R and Maibach HI. "Hyaluronan in skin: aspect of aging and ist pharmacologic modulation". *Clinics in Dermatology* 26 (2008): 106-122.
15. Enomoto H., *et al*. "Filaggrin null mutations are associated with atopic dermatitis and elevated levels of IgE in the Japanese population: a family and casecontrol study". *Journal of Human Genetics* 53 (2008): 615-621.

16. Hauge HH., *et al*. "Plantaricin A is an amphiphilic alpha-helical bacteriocin-like pheromone which exerts antimicrobial and pheromone activities through different mechanisms". *Biochemistry* 37.46 (1998): 16026-16032.

17. Pinto D., *et al*. "Plantaricin A synthesized by Lactobacillus plantarum induces in vitro proliferation and migration of human keratinocytes and increases the expression of TGF-β1, FGF7, VEGF-A and IL-8 genes". *Peptides* 32.9 (2011): 1815-1824.

18. Marzani B., *et al*. "The antimicrobial peptide pheromone Plantaricin A increases antioxidant defenses of human keratinocytes and modulates the expression of filaggrin, involucrin, β-defensin 2 and tumor necrosis factor-α genes". *Experimental Dermatology* 21.9 (2012): 665-671.

19. Pinto D., *et al*. "Scalp bacterial shift in Alopecia areata". *PLoS one* 2019 14.4 (2019): e0215206.

20. Di Cagno R., *et al*. "Novel solid-state fermentation of bee-collected pollen emulating the natural fermentation process of bee bread". *Food Microbiology* 82 (2019): 218-230.

21. Curiel JA., *et al*. "Lactic acid fermentation as a tool to enhance the antioxidant properties of Myrtus communis berries". *Microbial Cell Factories* 14 (2015): 67.

22. Verni M., *et al*. "How Fermentation Affects the Antioxidant Properties of Cereals and Legumes". *Foods* 8.9 (2019): E362.

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