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Beneficial Effects of Post-biotics on Food Products and its Effect on Human Health: a Critical Review

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Abstract

The human intestinal microbiota is a collection of microorganisms that reside in the gastrointestinal tract and there is a direct link between the presence of beneficial microbiota and the development of immune function, the nervous system and the host metabolic pathways. Probiotics are known to be non-pathogenic microorganisms that, if taken in sufficient amounts, can have health effects. Therefore, consumption of foods or supplements containing post-biotic compounds is one of the most important strategies to balance the microbiota and to improve the health of the host. Evidence suggests that post-biotics do not require survival compared to their parent probiotic cells and can produce health-like effects similar to probiotics. Also, the production and use of post-biotics is safer, more stable and more cost-effective. Post-biotics have biological activity, including immune modulating, anti-inflammatory, antioxidant, and anti-cancer activity. Clinical studies also confirm the efficacy of probiotics as an effective factor in improving the treatment of a wide range of diseases such as ulcerative colitis, acute infectious diarrhea, antibiotic resistant diarrhea, irritable bowel syndrome, necrotic enteritis, liver disorders, and gastrointestinal cancers. In this study, a review of the concept of post-biotics and classification of post-biotics has been done based on type and chemical composition and physiological activities and promising effects on prevention or

improvement in treatment methods as well as delaying spoilage and increasing shelf life in food products.

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Introduction

The composition of human microbiota is very high and varied and is related to various factors such as age, sex and nutrition [1]. Intestinal microbiota are examples of technological breakthroughs that have potential implications for both the food and medical sciences, Nutraceutical formulations, either supplements along with drugs or stand-alone therapeutics can be developed by combining probiotics and postbiotics to restore microbial balance in the gut [2]. Postbiotics in the first place due to their unique characteristics such as stability, safety and non-toxicity and in the second place due to having biological activities and creating health effects similar to their parent probiotic cells, they can be introduced as a safe alternative to probiotics [3]. The microbiome plays an important role in both nutrient processing and the immune system [4]. Such as allergies and pathogenesis of obesity, inflammatory diseases and neurological disorders. The term " postbiotics" is also known as bacterial or biogenic metabolites [2]. These are bioactive molecules with low molecular weight or a fraction of the various components derived from the microbiome. Postbiotics are then produced during the fermentation of intestinal bacteria or may be structural components of these bacteria. Studies show that microbial postbiotics have a great impact on the physiology of the host and affect human health [5,6]. Clinical studies also confirm the effectiveness of probiotics as an effective factor in improving the treatment of a wide range of diseases such as ulcerative colitis, acute infectious diarrhea, irritable bowel syndrome, antibiotic resistant diarrhea, necrotic enteritis, liver disorders and gastrointestinal cancers [7,8]. Today, most probiotics used in food supplements or pharmaceutical products belong to lactobacilli and bifidobacteria [9]. Also from a technological point of view, maintaining the viability of probiotics in different stages of production, storage and Distribution, selection of appropriate carriers, attempt to standardize the optimal amount of probiotics according to The various metabolic activities of each and the costs required to achieve these goals in order to achieve health effects in the host, are always of concern to researchers and manufacturers and seek to reduce costs and improve product safety and consumer health [10].

The advantages of post-biotics in terms of safety, biological effects and application in the pharmaceutical and food industries compared to living probiotic cells are as follows:

Do not invade the intestine and enter the bloodstream, especially in susceptible individuals without worrying about the transfer of resistance factor genes to other microbiota without worrying about preventing the growth and development of other intestinal microbiota, especially in infants, Exercises its health effects through proper digestion and absorption, metabolism and proper distribution as soon as possible, High durability, ease of standardization and transportation [9]. In this review study, different types of postbiotics and mechanisms of action in the host and their health impact on the host body are examined.

Methodology

Database study

A complete the databases searched for in those articles were “Google Scholar”, “SID”, “Scapus”, “PubMed”, “Science Direct”, and “ISI” search engines. Search was done for articles published that included the search term containing Abiotic, Ghost probiotic, Postbiotic, Metabiotic, Supernatant, Health, Safety and benefit in their title. This study focused on published articles papers from 2011 to 2021. Exclusion criteria also included the following, articles with only

abstracts available, and studies written in languages other than English. Finally, 400 articles were found, 250 of which were discarded because they were not relevant to the purpose of the article. Then, abstracts of 150 related articles were prepared and studied. Finally, only 44 articles that were in line with the objectives and criteria of the present study were reviewed.

Definition and classification of postbiotics

A major part of the health effects of probiotic-containing products is related to the presence of post-biotic compounds in them. Postbiotics include the three major components of inactivated microbial cells (cell body), cell fractions (ticoic acid, peptidoglycan-derived morpopeptides, cell surface proteins, endo, and exopolysaccharides), as well as short-chain fatty acid cell metabolites (SCFAs). They are enzymes, bacteriocins and organic acids which are secreted when microbial cells are alive or released after they are broken down in the host intestinal environment And if received in sufficient quantities, they leave their own health effects on the host [9, 11-13]. In general, Postbiotics can be more complex due to their chemical structure (lipids, protein, carbohydrates, vitamins, and molecules). Classified potential biological activities such as anti-inflammatory, immune modulation, obesity prevention, blood pressure modulation, serum cholesterol lowering, and cessation of cell proliferation, antioxidant and anti-cancer (Figure 1) [14-18]. In addition, postbiotics have the ability to react with epithelial cells and the immune system, are metabolized by cytochrome P450 enzymes, have a good distribution, and have a high capacity to communicate with different organs and tissues in the host and can produce several physiological responses simultaneously. It is also important to note that postbiotics, like prebiotic compounds, develop probiotics in each individual's gastrointestinal tract instead of adding new species to the gut microbiota [19].

The effect of Postbiotics on health human

In recent decades, much attention has been paid to bioactive compounds such as probiotics, prebiotics and postbiotics. These compounds are closely related to the beneficial gut microbiota and promote the health status of the host. Prebiotics are indigestible food components that improve the health of consumers by stimulating the activity and selective growth of beneficial microbiota in the gastrointestinal tract. Postbiotics are also functional parts of living probiotics that have the ability to perform the biological and physiological functions of their living parent cells [20].

Table 2. Benefits of postbiotics in human health

Probiotic organisms	Health benefits	Ref
Lactobacillus spp	Anti-adhesion effect against *E. coli*	[21]
L. paraplantarum	Antagonistic effects against MRSA	[22]
L. fermentum	Anti-senescence potential (alleviated senescence markers viz. p53, p21WAF1, SA-β-gal, p38MAPK, iNOS, cox-2, ROS, NF-κB, and DNA damage response)	[23]
B. longum	Anti-inflammatory	[24]
L. casei	Anti-tumour effect	[25]
L. rhamnosus GG	Anti-inflammatory	[26]
L. brevis	Anti-inflammatory and Enhancement of epithelial barrier permeability	[27]
L. paracasei D3-5 strain	Anti-aging	[28]
L. gasseri	Antibiofilm ability against methicillin-resistant *S. aureus* (MRSA)	[29]
L. plantarum	Anti-adhesion and antimicrobial effects	[30]
L. plantarum	Antibiofilm activity against *S. mutans*	[31]
L. acidophilus DDS-1	Increases in short-chain fatty acids (butyrate, propionate, and acetate) levels	[32]

The effect of Postbiotics on food

The possible use of postbiotics in food instead of probiotics has technological advantages since the functionality does not depend on cell viability. These functional ingredients would allow a longer shelf life, easier storage, handling, and transportation [5]. Problems with

using probiotics are: First, they do not need to prove safety or purity before marketing because they are known as dietary supplements [33]. Second, in immunocompromised patients, probiotic bacterial species such as Lactobacillus, Leuconostoc, Pediococcus, Enterococcus, and Bifidobacterium can enter the bloodstream and damage patients' health [34]. In addition, patients with severe acute pancreatitis have an increased risk. Mortality is achieved by using a combination of bacteria that is used as a probiotic prophylaxis. Postbiotics can have the same benefits as probiotics without the risks associated with living organisms. Also, postbiotics are easily absorbed, metabolized, and excreted by different host organs and tissues that elicit different biological responses. Other health benefits of fermented foods are related to the bioavailability of biotics, as they are related not only to ingested microorganisms but also to microbial structures and metabolites produced during fermentation. Therefore, postbiotics have a high potential for the production of fermented foods and microbial fermentation due to their biogenic composition.

In industrial use, postbiotics are more stable and safer than probiotics, Because during industrial management, many factors related to food composition such as pH, protein, fat and carbohydrate concentration, water activity, the presence of natural antibiotics as well as processing and storage conditions can help reduce the strength of probiotic cells [35]. Therefore, the use of postbiotics in food products can offer several technological advantages compared to the same microorganisms suitable for food producers [36].

Table 3. Benefits of Postbiotics in the food.

Postbiotic	Food	Benefits	Ref.
Lactobacillus sakei NRRL B-1917 supernatant	Grilled beef	Decrease in counts of E. coli and L. monocytogenes. There were no sensory changes	[37]
Polysaccharide extracts from Lactarius volemus Fr.	Yoghurt	Decreased water holding capacity and reduced pH	[38]
Supernatant of Lactobacillus plantarum YML 007	Soy without shell	Increase shelf life	[39]
Lactobacillus gasseri LA39 Gassericin A bacteriocin	Custard cream	Complete inhibition of four decomposition strains	[40]
Bacteriocin-like inhibitor substance of Lactobacillus plantarum ST16Pa	Chicken breast	Bioconservative against Enterococcus faecium for 7 days	[41]
Pirrolo [1,2-a] and pyrazine-1,4-dione from Lactobacillus salivarius	Ground beef and whole milk	Biofilm removal of L. monocytogenes	[42]
Lactobacillus rhamnosus S93 enzyme	Cheddar cheese	Higher levels of soluble nitrogen in phosphotungstatic acid and free amino acids	[43]

Given the above, postbiotics can be an opportunity to develop new effective treatment strategies with better safety profiles, thus avoiding the risks associated with prescribing live microorganisms. Microorganisms. This new approach to the use of postbiotics relates not only to the therapeutic benefits but also to the dilution of food and the removal of some harmful components from food during probiotic fermentation [5, 44].

Conclusion

Unhealthy lifestyle, the prevalence of chronic diseases, the prevalence of infectious and non-infectious diseases and the high cost of treatment are among the important factors that lead people to improve their lifestyle and diet. On the other hand, due to increasing consumer awareness and increasing research in the field of healthy foods, today a new concept in the field of probiotic functional food has been formed which has raised many research challenges. Postbiotics are known for their immune-boosting, anti-cancer, and antioxidant effects. As a drug supplement, they have beneficial therapeutic effects, doing so while avoiding the risk of prescribing live microorganisms to the body. In other words,

post-antibiotics, like prebiotics, develop probiotics in each individual's digestive tract, indicating the supportive role of post-antibiotics in the growth of beneficial microbiota (probiotics) in the host. Postbiotics are also used to delay spoilage, extend the shelf life of food, and promote healthy foods. Thus, postbiotics pave the way for the production of new pharmaceutical or food products with physiological effects.

Conflict of interest

The authors declare no conflict of interest.

Consent for publications

All authors approved the final manuscript for publication.

Availability of data and material

Data are available on request from the authors.

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