

## PROBIOTIC FOODS – THY MEDICINE

### Abstract

The metabolic energy for body is obtained from food. The food with right proportions and composition of ingredients can act as a good medicine. The foods with certain beneficiary organisms like Lactic acid bacteria enrich the food with various health benefits improves overall gut health. These fermented foods with beneficiary microorganisms are called probiotic foods. The probiotic organisms can be considered as altruistic and in favor of human health aspects. "Probiotic foods are the secret to a thriving gut and flourishing us, supporting our immune system, digestion, and overall well-being with each delicious bite." Let us explore more about probiotic foods in this chapter.

**Keywords:** Probiotic Foods

### Authors

**Sai Bramari. G**

D. No. 8-3-668/1/B

Gandhi Residency

Jayaprakash Nagar, Yellareddy Guda

Hyderabad.

**Dr. L. Anitha**

Flat No : 401, Springwood Apartments

Tummalagunta Main Road

Behind Mahila University

Tirupati , Andhra Pradesh, India.

## I. INTRODUCTION

The age-old quote by Hippocrates ‘LET food be thy medicine and medicine be thy food’, demarcates the role of food between health and medicine. Gut bacteria play a key role in overall health of the humans. The harmful bacterial actions are countered by useful bacteria that help in improving health. These are the probiotic bacteria.

“Probiotics are the human-friendly and live microbial feed supplements that beneficially affect the host by improving its intestinal microbial balance.” The first ever probiotic food introduced was *Lactobacillus acidophilus* to the milk; this helped people develop better tolerance towards milk and also helped people who found it difficult to digest milk. The main probiotic foods available in the market are mainly fluid milk and yogurt.

Elie Metchnikoff discovered beneficial bacteria. The fermented food products provide number of health benefits by containing probiotic- organisms. While, some of these benefits have been well documented and established, others have shown a promising potential in animal models, with human studies required substantiate these claims. The most investigated probiotic cultures with the established human health efficacy data against management of lactose mal-absorption, rotaviral diarrhea, antibiotic - associated diarrhea and *Clostridium difficile* diarrhea, anti cancer effects, urogenital tract disorders etc.

## II. WHAT ARE PROBIOTICS, PREBIOTICS, SYNBIOTICS AND GERBIOTICS?

Probiotics are live microorganisms that confer a health benefits when consumed in adequate amounts. Typically, they are beneficial bacteria and sometimes yeasts that are similar to the beneficial microorganisms naturally found in the human gut. These microorganisms help to maintain a balanced and healthy gut microbiota, which is essential for digestion, immune function, and overall well-being.

Prebiotics are non-digestible dietary fibers or compounds that selectively promote the growth and activity of beneficial microorganisms, such as probiotics, in the gut. Unlike probiotics, prebiotics are not living organisms themselves but rather act as a food source for the beneficial bacteria in the colon. By nourishing these friendly bacteria, prebiotics help to maintain a healthy gut microbiome and support various aspects of digestive health. Foods rich in prebiotics include garlic, onions, bananas, asparagus, and whole grains.

Synbiotics refer to products or supplements that combine both probiotics and prebiotics. They are designed to have a synergistic effect by providing live beneficial microorganisms (probiotics) along with the necessary nourishment (prebiotics) to support their growth and activity in the gut. Synbiotics aim to enhance the overall effectiveness and survival of the probiotics, thus promoting a healthier gut environment.

Gerobiotics are a more recent concept in the field of probiotics. They refer to specific strains of probiotics or probiotic formulations that are believed to support healthy aging and improve various aspects of elderly individuals' well-being. As people age, there may be changes in the gut microbiota composition, which can impact health and immune function. Gerobiotics aim to address these changes and potentially improve digestive health, nutrient absorption, and immune function in older adults.

### III. PROBIOTICS AND HEALTH BENEFITS

Probiotic foods are known for their potential health benefits, primarily attributed to the live beneficial bacteria they contain. These bacteria can positively influence the gut microbiota and support various aspects of human health. Some general health benefits associated with consuming probiotic foods are listed below.

- 1. Improved Digestive Health:** Probiotic foods can enhance gut health by promoting a balanced gut microbiota. They help in reducing symptoms of gastrointestinal disorders like irritable bowel syndrome (IBS), bloating, and constipation.
- 2. Enhanced Immune Function:** Probiotics can modulate the immune system, leading to improved immune responses. Regular consumption of probiotic foods may help reduce the frequency and severity of respiratory and gastrointestinal infections.
- 3. Reduction of Inflammation:** Probiotics may contribute to reducing chronic inflammation in the body, which is associated with various health conditions, including inflammatory bowel disease (IBD), allergies, and certain metabolic disorders.
- 4. Reduction of Blood Cholesterol Levels:** Some probiotic strains were found to reduce LDL (bad) cholesterol levels, and potentially contributing to cardiovascular health.
- 5. Regulation of Blood Sugar Levels:** Probiotics may positively impact glucose metabolism, promoting better blood sugar control and potentially benefiting individuals with diabetes or at risk of developing diabetes.
- 6. Mental Health Support:** Emerging evidence suggests a connection between gut health and mental health. Probiotic foods may have a positive impact on mood and mental well-being, potentially alleviating symptoms of depression and anxiety.
- 7. Enhanced Nutrient Absorption:** Probiotics can aid in the digestion and absorption of certain nutrients, including vitamins and minerals, leading to improved overall nutrient utilization.
- 8. Support for Weight Management:** Some studies suggest that probiotics may help with weight management and obesity by influencing gut bacteria related to metabolism and energy regulation.
- 9. Prevention of Antibiotic-Associated Diarrhea:** Probiotics can be beneficial for individuals undergoing antibiotic treatment by reducing the risk of antibiotic-associated diarrhea.
- 10. Potential Anti-Cancer Effects:** While more research is needed, some studies indicate that probiotics may play a role in modulating factors associated with cancer development and progression.

It's essential to note that the health benefits of probiotic foods can vary depending on the specific strains of bacteria present, the individual's health status, and other dietary

and lifestyle factors. As the research in this field is ongoing, it is crucial to stay updated with the latest scientific findings to understand the full potential of probiotics for human health.

#### IV. PROBIOTIC FOODS

Probiotic foods have been consumed for centuries in various cultures, and today, there is a wide range of traditional and modern probiotic food products available. Below is a list of some traditional and latest probiotic food products:

**Table 1: Asian Traditional Probiotic Foods**

S.No	Name	Food Resource	Probiotic Species
1.	Yogurt	A fermented dairy product made by adding live bacterial cultures and some yogurts also contain additional probiotic strains.	Lactobacillus bulgaricus and Streptococcus thermophilus
2.	Kefir	A fermented milk drink, similar to yogurt, but fermented with a different set of probiotic cultures	Lactobacillus kefirifaciens and various yeast strains
3.	Sauerkraut	Fermented cabbage with lactic acid bacteria	Lactobacillus plantarum
4.	Kimchi	A traditional Korean side dish made of fermented vegetables (usually cabbage and radishes) with added spices	probiotic bacteria
5.	Miso	A Japanese seasoning made by fermenting soybeans and other ingredients. It is commonly used in soups and sauces.	koji (a type of fungus)
6.	Tempeh	An Indonesian fermented soybean product that contains the probiotic fungus	Rhizopus oligosporus
7.	Natto	Another Japanese probiotic food made by fermenting soybeans with the bacteria	Bacillus subtilis

**Table 2: Indian Traditional Probiotic Foods**

S.No	Name	Food Resource	Probiotic Species
1.	Dahi	Yogurt /Curd	Lactobacillus bulgaricus, Streptococcus thermophilus, Lactobacillus acidophilus, Bifidobacterium bifidum
2.	Chhaach/Lassi	Buttermilk	Lactobacillus bulgaricus, Streptococcus thermophilus, Lactobacillus acidophilus, Lactobacillus helveticus
3.	Fermented	Fermented Pickles	Lactobacillus brevis,

	Pickles		Lactobacillus plantarum, Lactobacillus pentosus.
4.	Breakfast foods	Idli and Dosa	Lactobacillus acidophilus, Lactobacillus fermentum, Lactobacillus plantarum.
5.	Dhokla	Traditional gujarathi food	Lactobacillus delbrueckii, Lactobacillus fermentum, Lactobacillus plantarum.
6.	Kanji	Rice soup	Lactobacillus brevis.
7.	Kombucha	a fermented tea	Acetobacter spp., Saccharomyces spp
8.	Fermented Lentils	Urad dal	Lactobacillus acidophilus, Lactobacillus fermentum, Lactobacillus plantarum.
9.	Gajar Kanji	a fermented carrot drink	Lactobacillus brevis.
10.	Fermented Rice	Panta Bhat	Lactobacillus casei, Lactobacillus acidophilus
11.	Khorisa	Fermented Bamboo Shoots	Lactobacillus plantarum

## V. LATEST PROBIOTIC FOOD PRODUCTS

- 1. Probiotic-Enriched Functional Beverages:** These include juices, smoothies, and other drinks fortified with specific probiotic strains.
- 2. Probiotic Chocolates and Confectionery:** Some manufacturers are incorporating probiotics into chocolate and other sweet treats.
- 3. Probiotic Granola Bars and Snacks:** Snack foods are being developed with added probiotic strains to provide a convenient way to consume probiotics on-the-go.
- 4. Probiotic Dairy-Free Alternatives:** Non-dairy products like almond milk, coconut milk, and soy-based yogurt are now available with added probiotic cultures.
- 5. Probiotic Supplements:** These come in various forms, such as capsules, tablets, and powders, providing a concentrated dose of probiotic bacteria.
- 6. Fermented Plant-Based Foods:** Apart from traditional sauerkraut and kimchi, there are now variations using different vegetables, such as fermented carrots or beets.
- 7. Probiotic Cheeses:** Some cheese varieties are being developed with added probiotic strains to provide additional health benefits.
- 8. Probiotic Frozen Desserts:** Ice creams and frozen yogurts are now being made with live probiotic cultures.

Probiotic fruit juices could serve as a better medium. Fruits are healthy foods because they are rich in anti-oxidants, Vitamins, dietary fibers and minerals. Various species of genera *Lactobacillus* and *Bifidobacterium* mainly and some other species of micro-organisms have been used as probiotics over the years.

## VI. THE PROBIOTIC GUAVA FRUIT BEVERAGE AND ITS BENEFITS

We have undertaken a pilot research project of the preparation of probiotic guava fruit beverage. The fermentation substrate used was the Guava fruit beverage. The *Lactobacillus* strains were isolated from milk, curd and whey. The Guava fruit beverage has been prepared as per composition makes it as an ideal probiotic fruit juice. The guava fruit helps to reduce the cholesterol levels and strengthens the immune system. It possesses many phyto-radicals and antioxidants which help in protection from cancer.

Guava fruit has a high content of protocatechuic acid, quercetin, ferulic acid, ascorbic acid, gallic acid and caffeic acid which are important antioxidants. Guava fruit mainly cures the dysentery and diarrhea and strengthens digestive system. Guava possesses astringent and antiseptic properties, which have long been used for treating diarrhea, particularly the one caused by *Staphylococcus* or *Salmonella*. It provides gum care and prevents toothache and controls the blood pressure. It is rich in vitamin A and C and also provides resistance against pathogens.

- 1. Preparation of Guava Fruit Beverage:** Fresh guavas were purchased from the market. They were thoroughly washed and cleaned. The skin was removed and the guava fruits were made into pulp adding little amount of filtered water. Using kitchen mixer and juicer the fruits were made into pulp. The pulp was passed through kitchen strainer to remove seeds. Later, guava fruit beverage was prepared with pulp as per following composition.

**TABLE 3:**

GUAVA PULP	1LITRE
SUGAR	1.5 Kg
CITRIC ACID	22 Grams
WATER(FILTERED)	750ml.
SODIUM BENZOATE	2.0 Grams (Preservative)
RASPBERRY RED COLOUR	1 DROP

The concentrated Guava fruit beverage so prepared was diluted in 1:3 proportions with filtered water and distributed into clean, dry and sterilized glass bottles.

The isolated *Lactobacilli* were introduced into the diluted Guava fruit beverage and subjected to fermentation by incubating at 30<sup>0</sup>C and 4<sup>0</sup>C and shelf life of fermented Guava fruit beverage was checked at the above temperatures. After fermentation the Guava fruit beverage was analyzed to check its p<sup>H</sup>, titrable acidity, sugar estimation and viable Cell Counts of inoculated *Lactobacilli*.

- 2. Outcome of the Study:** It was finally concluded that all isolates used for fermentation of Guava fruit beverage were capable of utilising the Guava fruit beverage for their growth,

synthesis and metabolism. The fermentation analysis results suggest that isolates were capable of fermentation. The color, flavor and taste of fermented Guava fruit beverage was found to be acceptable. The color was deep pink with a creamy tinge and was accepted 100%. The taste was also accepted by 99% and flavor was by 95% of people. The richness of fruit qualities and goodness of probiotic strains blend together to make Guava fruit beverage as an ideal probiotic fruit beverage and acceptable to all vegetarians who were allergic to dairy products.

## VII. MARKET VALUE OF PROBIOTIC FOODS

The market value of probiotic food products can change rapidly due to various factors, including consumer trends, product innovations, and global economic conditions. To find the most up-to-date information on the global market value of probiotic food products, I recommend consulting market research reports, industry analyses, and reputable business news sources that focus on the food and beverage sector. These sources often provide the latest data and insights on market trends, growth projections, and key players in the probiotic food industry.

As of 2022, the global Probiotics Market was valued at approximately USD 62.4 billion. It is projected to experience substantial growth and reach around USD 131 billion by the year 2032, with a Compound Annual Growth Rate (CAGR) of 7.9% during the forecast period from 2023 to 2032.

In terms of ingredients, the probiotic Bacteria segment emerged as the top revenue generator in 2022. Meanwhile, in the Functional category, Preventative Healthcare dominated the market and is expected to maintain significant growth from 2023 to 2032.

The Asia-Pacific Region was the leading market for probiotics in 2022, accounting for the highest revenue share at 42%. Following closely, the North America Region secured the second position in terms of probiotics revenue in the same year. The Asia-Pacific markets are anticipated to experience remarkable growth during the period from 2023 to 2032.

Shifting our focus to India's probiotics market, it was valued at INR 2.6 Billion in 2021. Looking ahead, experts at IMARC Group anticipate a remarkable expansion, reaching INR 7.7 Billion by 2027, with an impressive CAGR of 20.50% from 2022 to 2027.

## VIII. LATEST RESEARCH ON PROBIOTICS

There are several ongoing research areas and studies related to probiotic food products. Some areas of ongoing research in probiotic food products include:

- 1. Strain-Specific Health Benefits:** Researchers are investigating the health benefits of specific probiotic strains and their potential effects on various health conditions, such as digestive disorders, immune function, and metabolic health.
- 2. Gut-Brain Axis:** Studies are exploring the interactions between the gut microbiota and the brain, focusing on how probiotics may impact mental health, mood, and cognitive function.

3. **Novel Probiotic Strains:** Researchers are identifying and characterizing new probiotic strains from different sources, such as plants and non-dairy fermentation processes, to expand the variety of probiotic food products available.
4. **Microbiota Modulation:** Scientists are studying how probiotic foods can influence the composition and diversity of the gut microbiota, aiming to better understand the mechanisms behind their health effects.
5. **Synbiotics:** Synbiotics are products that combine probiotics with prebiotics (food for beneficial bacteria). Researchers are investigating the synergistic effects of synbiotic formulations on gut health and overall well-being.
6. **Probiotics In Non-Dairy Products:** There is growing interest in developing probiotic food products suitable for individuals with lactose intolerance or those seeking dairy-free alternatives.
7. **Probiotics for Specific Health Conditions:** Studies are examining the potential of probiotic food products for managing conditions such as inflammatory bowel disease, allergies, obesity, and diabetes.
8. **Food Matrices and Delivery Systems:** Research is focused on optimizing the delivery of probiotic strains in food products to ensure their survival during processing, storage, and passage through the gastrointestinal tract.
9. **Safety and Efficacy:** Ongoing research aims to ensure the safety and efficacy of probiotic food products, especially for vulnerable populations such as infants, the elderly, and individuals with compromised immune systems.

## IX. ADVANCED TECHNOLOGIES USED IN PROBIOTIC FOOD PRODUCTION

Recent advancements in technologies used in probiotic food production, processing, and preservation are aimed to improve the viability, stability, and functionality of probiotics in food products.

1. **Microencapsulation:** Microencapsulation involves enclosing probiotic bacteria in protective coatings to enhance their survival during processing and storage. This technology helps improve probiotic stability and allows for the development of new probiotic food formats, such as powders, capsules, and functional foods.
2. **Freeze Drying (Lyophilization):** This is a common method used for the preservation of the probiotic strains that involves the removal of moisture and maintaining their viability. This process extends the shelf life of probiotic food products and makes them more convenient for consumers.
3. **Spray Drying:** Similar to freeze drying, spray drying is a technique that involves converting liquid probiotic cultures into dry powder form. It helps enhance probiotic stability and facilitates incorporation into various food matrices.



4. **High-Pressure Processing (HPP):** HPP is a non-thermal food preservation method that uses high pressure to inactivate harmful microorganisms while preserving the viability of probiotics. It is especially useful for producing refrigerated probiotic beverages and foods.
5. **Fermentation Optimization:** Advances in bioprocessing and fermentation technologies allow for better control and optimization of probiotic fermentation processes. This leads to higher probiotic cell counts and improved consistency in probiotic food products.
6. **Genomic and Proteomic Techniques:** DNA sequencing and proteomic analysis are used to identify and characterize probiotic strains, ensuring their safety and functionality in food products.
7. **Prebiotics in Synbiotic Formulations:** Prebiotics are non-digestible food components that promote the growth of beneficial bacteria. Combining prebiotics with probiotics (synbiotics) enhances the survival and activity of probiotics in the gut.
8. **Protective Cultures:** The use of protective cultures, which are non-probiotic bacteria, can help shield probiotics from adverse conditions during food processing, thereby improving their viability.
9. **Encapsulation in Edible Films:** Probiotic bacteria can be encapsulated within edible films or coatings that provide additional protection during storage and help deliver probiotics to the intestine.
10. **Nanotechnology:** Nanotechnology is being explored to develop innovative delivery systems for probiotics, improving their stability and targeted delivery in the gastrointestinal tract.

These technologies are continuously evolving, and ongoing research aims to optimize their applications in probiotic food production, processing, and preservation. Manufacturers in the food industry are incorporating these advancements to develop a wider range of probiotic-enriched food products with enhanced health benefits and improved consumer experience.

## X. CONCLUSION

In conclusion, the chapter on probiotic foods and health benefits explores the significant role these foods play in promoting overall well-being and gut health. Throughout the chapter, we have delved into the various traditional probiotic-rich foods. These time-honored foods have been consumed for centuries, and their consumption has been associated with a range of positive health effects. The gut microbiota's delicate balance is critical for maintaining overall health, and probiotic foods can play a vital role in supporting this balance. The probiotic strains present in these foods can colonize the gut, forming a symbiotic relationship with the host, leading to various health benefits and a growing body of scientific evidence supporting their health benefits. Embracing these probiotic-rich foods as part of a balanced diet may contribute to improved gut health and overall well-being. Furthermore, emerging research suggests that probiotics may have a positive impact on

mental health, with potential effects on mood and anxiety regulation, though further investigations are warranted in this area.

## BIBLIOGRAPHY

- [1] American Gastroenterological Association. Probiotics. (<https://www.gastro.org/practice-guidance/gi-patient-center/topic/probiotics>) Accessed 3/9/2020.
- [2] B.B. Lewis, C.G. Buffie, R. Carter, I. Leiner, N.C. Toussaint, L. Miller, *et al.* Loss of microbiota-mediated colonization resistance to clostridium difficile infection is greater following oral vancomycin as compared with metronidazole, *J Infect Dis*, 212 (2015), pp. 1656-1665
- [3] Bramari.G, S., & Mandlik, P. (2014). Formulation of Guava Fruit Beverage with Isolated Probiotic Strains.theinternationaljournal.org, Corpus ID: 219106653, *Clin Perinatol*, 40 (2013), pp. 11-25.
- [4] Day RL, Harper AJ, Woods RM, Davies OG, Heaney LM. Probiotics: current landscape and future horizons. *Future Sci OA*. 2019 May 3;5(4):FSO391. doi: 10.4155/fsoa-2019-0004. PMID: 31114711; PMCID: PMC6511921.
- [5] Hylemon, Phillip B. Mitropoulou, Gregoria, Nedovic, Viktor Goyal, Arun ,Kourkoutas, Yiannis, 2013/10/28, Immobilization Technologies in Probiotic Food Production, 716861, 2013; <https://doi.org/10.1155/2013/716861>, 10.1155/2013/716861, *Journal of Nutrition and Metabolism*; Hindawi Publishing Corporation.
- [6] J. Lloyd-Price, G. Abu-Ali, C. Huttenhower, The healthy human microbiome, *Genome Med*, 8 (2016), pp. 1-11.
- [7] Kieps, J.; Dembczyński, R. Current Trends in the Production of Probiotic Formulations. *Foods* **2022**, *11*, 2330. <https://doi.org/10.3390/foods11152330>
- [8] Lejandra Hurtado-Romero, Mariano Del Toro-Barbosa, Luis Eduardo Garcia-Amezquita, Tomás García-Cayuela, Innovative technologies for the production of food ingredients with prebiotic potential: Modifications, applications, and validation methods, *Trends in Food Science & Technology*, Volume 104, 2020, Pages 117-131, ISSN 0924-2244, <https://doi.org/10.1016/j.tifs.2020.08.007> (<https://www.sciencedirect.com/science/article/pii/S0924224420305653>)
- [9] Market.US. (2023, March 16). Probiotic Market Size is Expected to Reach USD 131 Bn by 2032; Food and Beverage Industry Drives the Growth. *GlobeNewswire News Room*. <https://www.globenewswire.com/en/news-release/2023/03/16/2628961/0/en/Probiotic-Market-Size-is-Expected-to-Rreach-USD-131-Bn-by-2032-Food-and-Beverage-Industry-Drives-the-Growth.html>
- [10] Aziz, Q., Doré, J., Emmanuel, A., Guarner, F., & Quigley, E. M. (2012). Gut microbiota and gastrointestinal health: current concepts and future directions. *Neurogastroenterology and Motility*, 25(1), 4–15. <https://doi.org/10.1111/nmo.12046>
- [11] Patel RM, Denning PW. Therapeutic use of prebiotics, probiotics, and postbiotics to prevent necrotizing enterocolitis: what is the current evidence? *Clin Perinatol*. 2013 Mar;40(1):11-25. doi: 10.1016/j.clp.2012.12.002. Epub 2013 Jan 17. PMID: 23415261; PMCID: PMC3575601.
- [12] Ranjan, A. (2023a, February 27). India Probiotics Market Size is Anticipated To Reach INR 7.7 Billion by 2027, Industry Growth Rate (CAGR) of 20.50%. *EIN News*. [https://www.einnews.com/pr\\_news/619308895/india-probiotics-market-size-is-anticipated-to-reach-inr-7-7-billion-by-2027-industry-growth-rate-cagr-of-20-50](https://www.einnews.com/pr_news/619308895/india-probiotics-market-size-is-anticipated-to-reach-inr-7-7-billion-by-2027-industry-growth-rate-cagr-of-20-50)
- [13] Thursby E, Juge N. Introduction to the human gut microbiota. (<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5433529/>) *Biochemical Journal*. Jun 2017; 474(11): 1823-1836. Accessed 3/9/2020
- [14] Tridip K. Das, Shrabani Pradhan, Sudipta Chakrabarti, Keshab Chandra Mondal, Kuntal Ghosh, Current status of probiotic and related health benefits, *Applied Food Research*, Volume 2, Issue 2, 2022, 100185, ISSN 2772-5022, <https://doi.org/10.1016/j.afres.2022.100185>. (<https://www.sciencedirect.com/science/article/pii/S2772502222001457>)
- [15] US Department of Health and Human Services, National Center for Complementary and Integrative Health. Probiotics: What You Need To Know. (<https://nccih.nih.gov/health/probiotics/introduction.htm#hed1>) Accessed 3/9/2020.