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(REVIEW ARTICLE)

Probiotic yeasts: an updated review

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Abstract

Probiotics are defined as vital microorganisms which when ingested in suitable quantity offer a health benefit to the host**.** Probiotics are live microorganisms *(Bifidobacterium*, *Lactobacillus*, and a yeast, *Saccharomyces boulardi*) that can have beneficial effects on or inside body. Indian probiotic foods have a fascinating history deeply rooted in the country's rich cultural heritage. *Ayurveda* recognizes the importance of gut health and emphasizes the use of probiotic-rich foods to promote digestion, immunity, and overall well-being. Many probiotic products are formulated with beneficial bacteria (*Bifidobacterium, Lactobacillus*) and yeasts (*Saccharomyces boulardii*) for the purpose of preventing or recovering from bacterial or yeast infections in our different body parts, including, atopic dermatitis and acne, cavities and gum diseases, vaginal and urinary tract infections, and antibiotic associated diarrhea. It may also help to ease the symptoms of irritable bowel syndrome (IBS) and some other conditions. Indian probiotic food can alleviate digestive issues like bloating, gas, and constipation by promoting regular bowel movements. Indian probiotic foods may positively impact mental health by influencing gut microbiota composition and improving mood and cognitive function.

Keywords: *Ayurveda*; *Bifidobacterium*; Gut health; Gastrointestinal tract; *Lactobacillus*; Indian probiotics; *Saccharomyces boulardii*; Yeast; Yoghurt

1. Introduction

Probiotics are vital and beneficial organisms which offers the health benefits to the host organisms [5-25]. In other words, probiotics are also defined as vital microorganisms which when ingested in suitable quantity offer a health benefit to the host [5-30]. Probiotics are live microorganisms (microbes) that can have beneficial effects on or inside body [5-32]. Every human body is home to trillions of microorganisms that live with us and help to support our bodily functions and health. Not all of the microbes we may carry are helpful to us, some types, germs can be harmful [5-40]. But beneficial microbes, like probiotics, helps to control the potentially harmful types. Probiotic products contain select, beneficial types of microbes to add to the populations already living in body [5-40]. Many probiotics are oral supplements designed to be ingested into gastrointestinal tract. Probiotics are food and health products that contribute

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live, beneficial microbes to the populations within our gut and elsewhere, in order to strengthen those communities [5-45]. Many probiotic products are formulated with beneficial bacteria and yeasts for the purpose of preventing or recovering from bacterial or yeast infections in our different body parts, including, atopic dermatitis and acne, cavities and gum diseases, vaginal and urinary tract infections, and antibiotic associated diarrhea [5-47]. Fermented foods in market like yogurt, cottage cheese, soup, pickle and pickle juice contains probiotics. Fermented foods and drinks are one way to get more probiotics into Gastrointestinal tract (GI) [5-40-71]. Food processing can sometimes destroy these natural probiotics. There is a lot of research in progress on the potential benefits of probiotics, and initial results are promising [5-49]. Different probiotic products may helped to improve skin health, vaginal health, gut health and build-up immunity in general [5-46]. Probiotics and prebiotics are two parts of food that may support gut health. Probiotics are specific living microorganisms, most often bacteria or yeast that help the body to digest food or help with symptoms of certain illnesses [5-47]. Probiotics are naturally found in fermented foods such as yogurt and sauerkraut. **Prebiotics** are parts of food, that body does not digest but that may be used by microorganisms [5-49]. Prebiotics may trigger the growth of the "good" germs in the gut. Prebiotics mainly are in high-fiber foods [5-50]. Probiotics and prebiotics are also added to some foods and come in the form of dietary supplements. When mixed, probiotics and prebiotics are called synbiotics [5-50]. Researchers continue to look for a link between gut microorganisms and health conditions. This includes conditions such as allergies, diabetes, obesity, vaginal diseases, depression, irritable bowel syndrome, preventing allergies, colds, dental cavities and gum disease [5-55]. Many types of bacteria are classified as probiotics. They all have different benefits, but the most come from two groups, *Lactobacillus* and *Bifidobacterium* [5-57, 68-71]. *Lactobacillus* may be the most common probiotic. It is the one in yogurt and other fermented foods. Different strains can help with diarrhea and may help people who can not digest lactose, the sugar in milk [5-57]. *Bifidobacterium* is available in some dairy products [68-71]. It may also help to ease the symptoms of irritable bowel syndrome (IBS) and some other conditions [5-57-71]. *Saccharomyces cerevisae* and *Saccharomyces boulardii* are yeast found in probiotics [5-57]. It appears to help to fight diarrhea and other digestive problems. In their earliest forms, probiotics were limited to dietary supplements, certain foods, and food additives targeting gut microbiome, the natural ecosystem of microorganisms in digestive tract [5-57, 66-71]. Our gut microbiome helps with the breakdown and absorption of nutrients and plays several important roles in immune system regulation and neurotransmitter production [5-60-71]. Probiotics have a long history. Trusted source of safe use in healthy people but may cause mild but temporary gastrointestinal side effects such as gas, bloating, diarrhea, or upset stomach. Despite their broad safety profile, probiotics are not for everyone. Certain populations, like infants, older adults, or people who are immunocompromized, can experience serious side effects [5-60, 66]. Although rare, probiotics for these groups may contribute to: increased infections, sepsis, medication interactions, difficulties with blood sugar management, and autoimmune flare-ups [5-60, 66]. Because probiotics can affect human or animal health positively and negatively under different circumstances. Probiotics are live microorganisms that are intended to have health benefits when consumed or applied to the body [66]. They can be found in yogurt and other fermented foods, dietary supplements, and beauty products. Cases of severe or fatal infections have been reported in premature infants who were given probiotics, and the U.S. Food and Drug Administration (FDA) has warned health care providers about this risk [5-60-71]. Although people often think of bacteria and other microorganisms as harmful “germs,” many are actually helpful. Some bacteria help to digest food, destroy disease-causing cells, or produce vitamins [5-60, 66]. Many of the microorganisms in probiotic products are the same as or similar to microorganisms that naturally live in our bodies [5-60]. Probiotics may contain a variety of microorganisms [5-60, 66-71].

The most common are bacteria that belong to groups called *Lactobacillus* and *Bifidobacterium*. Other bacteria may also be used as probiotics, and so may yeasts such as *Saccharomyces boulardii* [5-60, 66-71]. Probiotics may have a variety of effects in the body, and different probiotics may act in different ways [66-71]. Probiotics might help our body to maintain a healthy community of microorganisms or help body’s community of microorganisms return to a healthy condition after being disturbed, Probiotics also produce substances that have desirable effects, and influence our body’s immune response [5-60-71]. Probiotics have shown promise for a variety of health purposes, including prevention of antibiotic-associated diarrhea (including diarrhea caused by *Clostridium difficile*), vaginal infections, prevention of necrotizing *enterocolitis* and sepsis in premature infants, treatment of infant colic, treatment of periodontal disease**,** and induction or maintenance of remission in ulcerative colitis [5-60, 66-71]. The community of microorganisms that lives on us and in us is called the “microbiome,” and it’s a hot topic for research [5-60, 66-71].

2. Indian Probiotic Food

Probiotics are live microorganisms found in fermented foods or supplements that helped to colonize our gut [5-71]. These friendly bacteria helped and kept our digestive health in top shape by breaking down food, absorbing nutrients, and fighting off harmful bacteria [5, 12, 14, 23-30, 55, 66, 68, 71]. Probiotics aid in the absorption of essential vitamins and minerals, improved digestion, prevent symptoms of digestive discomfort, boost immunity, strengthen our body’s defenses' against infections, enhance our mood and support mental health [5-71]. On the flip side, prebiotics

are plant-based indigestible fibers that act as food for these beneficial microbes [5-71]. Some of the benefits of prebiotics are, nourish beneficial gut bacteria, helped to reduce inflammation in the gut, promote healthy bowel movements and stimulate the immune system [5-71]. Probiotics play a crucial role in maintaining optimal gut health. These beneficial bacteria work wonders by creating a harmonious balance within our digestive system [5-71]. By colonizing the intestines, probiotics helped to keep harmful bacteria in check and prevent them from taking over [5-71]. They contribute to a healthy gut by aiding in the breakdown and absorption of nutrients, supporting the production of essential vitamins, and promoting proper digestion [5-71]. Probiotics also helps to strengthen the intestinal barrier, which acts as a protective shield against pathogens and toxins [5-71]. Additionally, they can assist in reducing gastrointestinal discomfort, such as bloating and gas [5-71]. With their remarkable abilities, probiotics actively contribute to a well-functioning gut, promoting overall wellness and vitality [5-71]. Indian probiotic foods have a fascinating history deeply rooted in the country's rich cultural heritage [5, 12, 14, 23-30, 55, 66, 68, 71]. Tracing back centuries, Indian probiotics practices have been an integral part of Indian cuisine and traditional medicine systems. Traditional fermentation methods passed down through generations, played a vital role in preserving and enhancing the nutritional value of food [5, 12, 14, 23-30, 55, 66, 68, 71]. *Ayurveda* recognizes the importance of gut health and emphasizes the use of probiotic-rich foods to promote digestion, immunity, and overall well-being [5, 12, 14, 23-30, 55, 66, 68, 71]. Indian probiotic foods are a tribute to the knowledge and resourcefulness of the country's ancient people to their historical relevance and time-honoured fermentation procedures [5, 12, 14, 23-30, 55, 66, 68, 71]. The difference between probiotics and prebiotics is that these are live microorganisms that, when consumed in adequate amounts, provide various health benefits of probiotics for women by improving the balance of beneficial bacteria in the gut [5, 12, 14, 23-30, 55, 66, 68, 71]. Prebiotics, on the other hand, are non-digestible fibers that served as food for the beneficial bacteria in the gut, promoting their growth and activity. Some of the plethora of health benefits of probiotics are enhanced digestion, stronger immune system, mood-boosting magic, weight management support, clear glowing skin, heart health booster and improved mental health [5, 12, 14, 23-30, 55- 71]. This amalgamation of natural probiotic foods and Indian cuisine represents a harmonious blend of ancient wisdom and modern wellness, emphasizing the importance of nourishing both the body and the gut [5, 12, 14, 23-30, 55, 66, 68, 71]. As probiotic foods become increasingly integrated into everyday Indian meals, the culinary landscape expands, offering a myriad of possibilities to explore the symbiotic relationship between taste, tradition, and health [5, 12, 14, 23-30, 55, 66, 68, 71].

In one of the study reported by **Malabadi** (1994) [3], Malabadi and Raghvendra (1994) [4], Malabadi and Raghavendra (1995) [2], sixty yeast were isolated from Dharwad, Karnataka State, India of different natural substrates such as flowers, fruits, soil, biodegrading materials and sugary substances [2, 3, 4]. Ten yeast isolates were identified as *Candida utilis*, *Torulopsis versatilis, Pichia pinus, Saccharomyces cervisiae*, *Candida rhagii*, *Cryptococcus luteolus*, *Saccharomyces fermentatis*, and *Kluyveromyceas* species [2, 3, 4]. Samples of natural substrates such as nectars of flowers, fruits, dry raisins, insects like hony bees, decying organic materials, molasses, jaggery, honey and water samples were collected [2, 3, 4]. Samples were transferred to 1ml sterile vials. By adopting the techniques of pour plate method, streak method, and serial dilution methods, the microorganisms were cultured on Petri dishes containing Wickerhams medium [74, 75] (Yeast Malt Agar (YM Agar medium) [2, 3, 4, 72, 73]. The YM agar medium [74, 75] was consisting of 3g lit^{-1} of yeast extract, 3g lit^{-1} of malt extract, 5g lit^{-1} of peptone, 10g lit^{-1} of glucose, and 20g lit^{-1} of agar. The pH of the medium was adjusted to 4. 5 using diluted HCL [2, 3, 4]. The media was sterilized at 121 ^{o} C for 15 min. The inoculated Petri dishes were incubated at 28 ^{o} C for 72 hours [2, 3, 4]. The growth of microorganisms was observed microscopically and on the basis of observation, yeast colonies were marked and separated [2, 3, 4]. The yeast isolates were identified on the basis of methods of Lodder, 1970 [72] and Barnett et al., 1983 [73]. Yeast isolates were identified on the basis of morphological, cultural, sexual, and physiological characteristics including Diazonium blue salt (DBB test), urease test, cycloheximide (Actidione reaction test), assessing vitamin requirements and fermentation ability of different carbon sources [2, 3, 4, 72, 73]. **Wickham's medium**, also known as Yeast Malt Agar (YM Agar), is a non-selective growth medium primarily used for cultivating yeasts, molds, and other aciduric microorganisms. It is formulated with yeast extract, malt extract, peptone, and agar. YM Agar can be further modified to enhance selectivity by acidification or adding antibiotics [2, 3, 4, 72, 73].

3. Examples of Indian Probiotic Food

Indian probiotic foods, such as yogurt and buttermilk, contain live cultures of beneficial bacteria that helps to maintain a healthy balance of microorganisms in the gut [5, 12, 14, 23-30, 55, 66, 68, 71]. These natural probiotic foods aid digestion, improve nutrient absorption and support overall gut health [5- 71]. Probiotics in Indian fermented foods helped to break down complex carbohydrates and enhance the digestion process [5, 12, 14, 23-30, 55, 66, 68, 71]. Indian probiotic food can alleviate digestive issues like bloating, gas, and constipation by promoting regular bowel movements [5, 12, 14, 23-30, 55, 66, 68, 71]. The probiotics found in Indian probiotic foods stimulate the immune system, helping to strengthen the body's defenses against infections, viruses, and harmful bacteria [5, 12, 14, 23-30, 55, 66, 68, 71]. For the immune system to work at its best, the microbiome in the gut must be healthy [5-71]. Probiotic foods improved to

the absorption of essential nutrients, such as vitamins and minerals, by enhancing the gut's ability to break them down and make them more bioavailable to the body [5-71]. Certain probiotics found in Indian probiotic foods may also helped to regulate body weight [5-71]. These probiotics for weight loss can influence and increase appetite, and improved insulin sensitivity, potentially contributing to weight management efforts [5-71]. Early exposure to probiotics through Indian probiotic foods, such as yogurt, may reduce the risk of allergies and eczema in infants and children [5-71]. Various sources of probiotics can modulate the immune system and promote a healthy immune response [5-71]. One of the benefits of probiotics for women, these Indian probiotic foods, like yogurt, contain strains of bacteria that support vaginal health by maintaining a healthy pH balance and preventing the overgrowth of harmful microorganisms [5-71]. Emerging research suggests a connection between the gut and the brain, known as the gut-brain axis [5-71]. Indian probiotic foods may positively impact mental health by influencing gut microbiota composition and improving mood and cognitive function [5-71]. Incorporating these probiotic-rich foods into a balanced diet can contribute to overall well-being by supporting digestive health, strengthening the immune system, and promoting optimal nutrient absorption [5-71]. Indian probiotic foods can play a beneficial role in managing lactose intolerance, a condition characterized by the inability to digest lactose [5-71]. They can also help to produce their lactase enzyme, improved digestion of lactose, reduce symptoms, improve gut microbiota, and prevent secondary symptoms [5-71].

Although presently India represents less than 1 per cent of the global probiotic share, it is the most potential market for probiotic products because of a growing interest in health care and need for preventive medicine [5, 12, 14, 23-30, 55, 66, 68, 71]. Probiotic drugs account for over 90 per cent of the market in India, followed by milk and milk products [5, 12, 14, 23-30, 55, 66, 68, 71]. Probiotic foods, on the other hand, are regulated by a set of food laws that aim to regulate general food items as defined by the recently established Food Safety and Standards Authority of India [5, 12, 14, 23-30, 55, 66, 68, 71]. The Indian Council of Medical Research and Department of Biotechnology have formulated guidelines for probiotics being marketed as foods [5, 12, 14, 23-30, 55, 66, 68, 71]. These guidelines specify the criteria that need to be borne when launching a probiotic food in the country [5, 12, 14, 23-30, 55, 66, 68, 71]. These guidelines also specify the labeling requirements for probiotic products in India [5, 12, 14, 23-30, 55, 66, 68, 71]. These guidelines may be used as a reference to establish the much needed probiotic standards in the country by the Food Safety and Standard authority of India [5, 12, 14, 23-30, 55, 66, 68, 71]. Following are the few well known Indian probiotic food in the market.

Curd or Yoghurt is one of the most popular probiotic food in India. It is made by fermenting milk with lactic acid bacteria, which helps to maintain a healthy balance of gut flora. Consuming curd regularly can aid digestion, boost immunity, and prevent stomach-related issues common during the monsoon [5, 12, 14, 23-30, 55, 66, 68, 71]. Enjoy it plain, or use it in dishes like Raita, Lassi, or Kadhi.

Buttermilk, or chaas, is a refreshing probiotic drink made by diluting curd with water and adding spices like cumin and coriander. It is light on the stomach and helps in cooling the body. Buttermilk aids in digestion and can alleviate bloating and acidity, making it an excellent choice for maintaining gut health during the humid monsoon season [5, 12, 14, 23-30, 55, 66, 68, 71].

Idli and dosa are traditional South Indian fermented foods made from rice and urad dal batter. The fermentation process enhances the nutritional value and makes these foods rich in probiotics. Including idli or dosa in our diet can improve digestion and provide beneficial bacteria to the gut, promoting overall digestive health [5, 12, 14, 23-30, 55, 66, 68, 71]. 4) Traditional Indian

Pickles, or achaar, are made by fermenting vegetables and fruits with spices and salt. The fermentation process produces beneficial bacteria that can aid in digestion and improved gut health. Pickles made from ingredients like mango, lime, and green chili are not only flavorful but also rich in probiotics [5, 12, 14, 23-30, 55, 66, 68, 71].

Kanji is a traditional North Indian probiotic drink made from fermented black carrots or beets. It is typically consumed during the winter and early spring, but it can be a great addition to our monsoon diet as well [5, 12, 14, 23-30, 55, 66, 68, 71]. Kanji is rich in beneficial bacteria and enzymes that promote a healthy digestive system. Its tangy taste is both refreshing and nutritious.

Gundruk is a traditional fermented leafy green vegetable dish from the Indian Himalayan region, particularly popular in Nepal and some parts of India. It is made by fermenting leafy greens like mustard, radish, or cauliflower leaves. Gundruk is a rich source of probiotics and can help to improve digestion and boost gut health, especially during the monsoon [5, 12, 14, 23-30, 55, 66, 68, 71].

Sol Kadhi is a traditional probiotic drink from the Konkan region of Maharashtra and Goa, India. It is made from kokum fruit and coconut milk, sometimes with the addition of fermented buttermilk. Sol Kadhi is not only a cooling beverage but also aids in digestion and soothes the stomach, making it a perfect drink for the monsoon.

Fermented rice, known as Panta Bhat in Bengali and Poita Bhat in Assamese, is a traditional dish where leftover cooked rice is soaked in water overnight to ferment. The fermented rice is consumed the next day with salt, onions, and green chilies. This dish is also rich in probiotics and helps to improve digestion and boost gut health.

High-fiber fruits: Bananas: This versatile fruit is rich in resistant starch, a type of fiber that feeds beneficial bacteria. They are particularly beneficial when unripe and widely consumed across the country. **Apples**: Besides offering a crunchy delight, apples contain pectin, a soluble fiber that supports a healthy gut by encouraging the growth of good bacteria and keeping the harmful ones in check. **Guava**: This tropical fruit is a fiber powerhouse, containing both soluble and insoluble fiber to keep our digestive system running smoothly.

Root vegetables: Carrots: A classic Indian ingredient, carrots are a good source of prebiotic fiber that can support gut health. Beetroots: These vibrant root vegetables contain beet fiber, which can benefit gut bacteria and improve digestion.

Legumes: Lentils: These are integral to many Indian recipes and are high in fiber, particularly resistant starch, which is great for nurturing gut bacteria. Chickpeas: Another staple in Indian meals, chickpeas contain soluble fiber that specifically feeds beneficial bacteria, fostering a healthy gut environment. **Whole grains**: Brown rice: A healthier alternative to white rice, brown rice is rich in fiber, including resistant starch, which can benefit our gut. Jowar (sorghum): Rich in fiber, jowar supports a diverse microbiota and adds to the richness of Indian cuisine.

Kanji and Kombucha are two probiotic beverages that have gained popularity in India for their health benefits and unique flavors. Kanji is a traditional drink from North India made by fermenting black carrots with water, mustard seeds, and other spices. Kombucha is a fermented tea beverage made by fermenting sweetened tea with a culture of bacteria and yeast known as a SCOBY (symbiotic culture of bacteria and yeast). Preparing Kanji and Kombucha at home is a relatively simple process, with the black carrots grated and mixed with water, mustard seeds, and spices, and then left to ferment for a few days. Kombucha requires brewing a batch of sweetened tea and allowing it to ferment for about a week. Incorporating Kanji and Kombucha into our diet can be a refreshing and beneficial choice. These probiotic beverages can be consumed independently as a healthy alternative to sugary drinks or paired with meals for added flavor and digestive support.

Miso (Soybean Fermentation): While miso is not Indian in origin, it has gained popularity and is used in some Indian recipes. Miso is a traditional Japanese seasoning made by fermenting soybeans with salt and a specific mould called koji. It can be added to soups, stews, and dressings to introduce probiotics into our diet.

Dhokla is a popular Gujarati snack made from fermented chickpea flour. The fermentation process adds probiotic bacteria, improving gut health. It enhances the taste, texture, and nutritional value of dhokla [5, 12, 14, 23-30, 55, 66, 68, 71]. During the fermentation process, the bacteria consume the carbohydrates in the batter, producing lactic acid as a by-product. This lactic acid not only adds a tangy taste but also helps in breaking down complex nutrients, making them more easily digestible [5, 12, 14, 23-30, 55, 66, 68, 71]. Additionally, the lactic acid bacteria produce certain enzymes and vitamins that further enhance the nutritional value of dhokla.

Kefir: like Miso, Kefir is not originally Indian but has gained popularity and is consumed in some parts of India. It is a fermented milk drink made using kefir grains, which contain a combination of bacteria and yeast. Kefir is known for its probiotic properties and is often consumed as a health drink. These Indian probiotics not only tantalize the taste buds but also contribute to gut health, immune function, improved digestion, and overall well-being [5, 12, 14, 23-30, 55, 66, 68, 71]. As awareness grows regarding the importance of a balanced gut microbiome, understanding the difference between probiotics and prebiotics becomes crucial. By incorporating Indian probiotic foods into our diets, we can embrace a flavorful and nourishing way to support our health [5, 12, 14, 23-30, 55, 66, 68, 71].

4. Probiotic Yeasts

Microfungi that reproduce by budding are indeed called yeasts [1-5]. Yeasts are single-celled fungi that reproduce asexually through a process called budding, where a small bud develops on the parent cell and eventually detaches to form a new individual [1-5]. Yeast has an enormous and diverse group of microorganisms that is attracting and expanding the attention from researchers and industries [1-5]. Yeasts are broadly used in biotechnological and

industrial applications for the production of fermented food products, including enzymes, acids and vitamins in large scale [1-5]. Yeasts are unicellular eukaryotic fungi and they belong to the phyla *Ascomycota* (e.g., *Saccharomyces*, *Debaryomyces*, *Candida* etc.,) and *Basidiomycota* (e.g., *Cryptococcus, Rhodotorula*) and can reproduce both asexually and sexually [1-5]. *Saccharomyces boulardii*, the only patented strain belonging to yeast genera for the human use, has been broadly evaluated for its probiotic effect [1-5-71]. Potential probiotic yeast having the potentiality to produce the commercially important compounds are used as cell factories in industrial applications [1-5-71]. As yeast is naturally resistant to antibacterial antibiotics which is one of the features of fungi, it seems to be an important attribute for the use as probiotic [1-5-71]. Yeast has attractive properties such as high nutritive value, antagonistic effect on other microorganisms, antibiotic resistance ability, good antioxidant status, cholesterol assimilation, immunomodulation of the host, inhibition of bacterial toxins [1-5-71]. *S. boulardii* (ICBN nomenclature is *S.cerevisiae* var. *boulardii*) is commercialized probiotic yeast used to treat against various gastrointestinal diseases [1-5-71]. Probiotic yeasts with their promising antimicrobial, antioxidant, anticancer properties, cholesterol assimilation and immunomodulatory effects can also be utilized as biotherapeutics [1-5-71]. *Saccharomyces boulardii* is a good antimicrobial agent and kills the pathogens. Probiotics are thought to exhibit a various mechanism such as cellular adhesion, interactions with brain-gut axis, mucin production, cellular antagonism, antitoxin effects, modulation of normal microbiome, immune regulations, metabolic regulations and signal pathway modification, physiological protection and pathogen competition [1-5-71]. *Saccharomyces boulardii* take part in a number of these effects as part of its probiotic properties. Probiotics also promote phagocytic activity, cell proliferation and production of secretary immunoglobulins IgA and IgM [1-5-71]. *Saccharomyces boulardii* can modulate immunological function by acting as a stimulant or a proinflammatory inhibitor. The plant growth promoting microorganisms promote the growth of plants by providing some beneficial results like fixing the atmospheric nitrogen, production of plant growth promoting hormones like auxin, cytokine and gibberellins, production of antibiotics, antifungal, vitamins and organic acids, by solubilizing the minerals and nutrients, having capability to reduce the several substances and toxins [1-5-71]. As yeast probiotics are highly tolerant to gastro intestinal enzymes, they also tolerate the pH variations and bile salt environments as well as organic acids [1-5-71]. Yeasts have numerous advantages in food, feed, fermentation, medicinal, agricultural, biofuel in ecological protection and also in chemical industries [1-5-71]. Probiotic yeasts with their hostile activity against pathogens and also as a virtuous plant growth promoting organism reduce the reliance on chemical fertilizers and fungicides [1-5-71]. Yeasts can also be used for the removal of noxious and other chemical contaminants and pollutants existing in the ecosystem [1-5-71]. Advanced and additional studies on these non-*Saccharomyces* yeasts are necessary prior to administer these yeasts as potential probiotics for health and well being. Further research and extensive studies are essential to exhibit their therapeutic properties [1-5-71].

There are reports on *Saccharomyces* (*S. cerevisiae*) and non-*Saccharomyces* yeast species having ability of higher pH tolerance, surviving capacity in bile and simulated gastric juice. However, the number of yeasts recognized as probiotics are very low, when compared to bacteria [1-5-71]. Yeasts belonging to the genera *Debaryomyces, Pichia, Yarrowia, Meyerozyma, Kluyveromyces* etc., have attained more interest because of their beneficial and probable probiotic features [1-5-71]. These yeast probiotics produce VOCs (Volatile organic compounds), mycocins and antimicrobials which shows the antagonistic effect against pathogenic fungi and bacteria [1-5-71]. Additionally, yeasts have been recorded as good plant growth promoting microorganisms. Yeast has an important role in environmental applications such as bioremediation and removal of metals like chromium, mercury, lead etc., from waste water [1-5-71].

Functional foods are part of our normal diet that contains biologically active compounds, which enhance health through its specific mechanisms [1-5-71]. Probiotics are considered as functional food which is defined as live microorganisms when administered in adequate amount confer health benefits on the host [1-5-71]. The bacteria such as *Lactobacillus* and *Pediococcus* and yeast (*Saccharomyces* sps.) are popular in probiotic use [1-5-71]. *Sccharomyces cerevesiae* var *boulardii* is the utmost common human yeast probiotic which is accessible in market presently [1-5-71]. Yeasts promotes both the human and animal health, also they intensify the bioavailability of minerals through hydrolysis of phytate, folate biofortification, detoxification of fungal toxins and xenobiotics [1-5-71]. Probiotics modify the hosts defenses against oxidative stress by the means of antimicrobial metabolite production, metal ion chelating and the antioxidant capability of probiotic helps in decreasing the gut microbiota [1-5-71]. Some yeasts other than *Saccharomyces* yeasts shown survivability in the digestive conditions, resistance to antibiotic which has made them the probable candidates as novel probiotics [1-5-71]. Some yeast produce mycocin which is also called as killer toxins [1-5-71]. Yeast's genera that produce mycocin or killer toxin include *Saccharomyces, Candida, Cryptococcus, Debaryomyces, Kluyveromyces, Pichia, Torulopsis* and *Zygosaccharomyces* [1-5-71]. The well-known mechanisms of the killer toxins are they block the synthesis of DNA and interrupt the cell division, killer toxin also inhibits component called β 1,3-glucan which is required for synthesis of cell wall [1-5-71]. These VOCs and killer toxins have the antagonistic effects against the pathogens. Probiotic yeast cells and the yeast metabolites showed virtuous antioxidant properties. The free radicals produced are neutralized by the chemical compounds called as antioxidants, but oxidative stress arises when endogenic antioxidants are deficient [1-5-71]. *Saccharomyces boulardii* is the most well studied probiotic fungus and basically a

model yeast, some studies specify that other yeasts may have potential as probiotics [1-5-71]. A yeast probiotic has been used efficiently in the management of different types of gastrointestinal disorders and also in numerous adverse health situations [1-5-71]. Some other strains of yeast also fulfilled the required probiotic properties, while some potentials make them a striking probiotic [1-5-71]. Their efficacy could be theoretically be improved by recombinant DNA technology to intensify inherent benefits or enhance new probiotic characteristics [1-5-71]. These probiotics can be used for heterologous expression of several proteins that can used as therapeutic agents. These probiotic yeasts can also be used in industrial and agricultural applications [1-5-71].

5. Conclusion

A yeast probiotic has been used efficiently in the management of different types of gastrointestinal disorders and also in numerous adverse health situations. *Saccharomyces boulardii* is a yeast found in probiotics. It appears to help to fight diarrhea and other digestive problems. Yeasts promotes both the human and animal health, also they intensify the bioavailability of minerals through hydrolysis of phytate, folate biofortification, detoxification of fungal toxins and xenobiotics. Probiotics modify the hosts defenses against oxidative stress by the means of antimicrobial metabolite production, metal ion chelating and the antioxidant capability of probiotic helps in decreasing the gut microbiota. The role of probiotics in the prevention and treatment of a variety of disorders that go beyond gut health (cancer, metabolic diseases, etc.) is increasingly being recognized. The role of probiotics as an alternative approach to normalize the microbial microbiota and thus prevent cancer is undergoing intense investigation. Interleukin-6 (IL-6) trans-signaling plays a role in the development of inflammation-based colon tumourigenesis. Probiotics are defined as live microorganisms which, when ingested in adequate amounts, confer health benefits on the host. Chronic diseases such as diabetes, non-alcoholic fatty liver disease, coronary artery disease, a variety of chronic inflammatory disorders with an immune basis, and some forms of cancer are increasing in incidence around the world and in India, and may be attributable in part to rapid changes in our lifestyle. There is considerable public interest in India in the consumption of probiotic foods. Therefore, background of the gut microbiota, the immunological reactions induced by these, the evidence linking the microbiota to health outcomes, and the evidence linking the use of probiotics for amelioration of chronic lifestyle diseases. Indian probiotics practices have been an integral part of Indian cuisine and traditional medicine systems. Traditional fermentation methods passed down through generations, played a vital role in preserving and enhancing the nutritional value of food. ***Ayurveda*** recognizes the importance of gut health and emphasizes the use of probiotic-rich foods to promote digestion, immunity, and overall well-being of human and animal health. Indian probiotic foods such as idly, dosa, bread, dokhla, Gundruk, aachar or pickles are a tribute to the knowledge and resourcefulness of the country's ancient people to their historical relevance and time-honored fermentation procedures

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Wedlich-Soldner R, Li R. Yeast and fungal morphogenesis from an evolutionary perspective. Semin Cell Dev Biol. 200;19(3):224-33. doi: 10.1016/j.semcdb.2008.01.003.

[2] Malabadi RB, Raghavendra S. Fermentation efficiency of yeasts isolated from Dharwad environment. Proceedings of the Eighty Second Sessions of the Indian Science Congress Association, Calcutta, West Bengal state, India. Part II, 35-38 (Full length conference Paper). 1995.

[3] Malabadi RB. Biology of yeasts isolated from the natural substrates in the environs of Dharwad. M.Phil Dissertation Thesis, Department of Botany, Karnatak University, Dharwad-580003, Karnataka state, India. 1994

[4] Malabadi RB, Raghavendra S. Studies on yeasts isolated from the environs of Dharwad. Proceedings of the Eighty First Sessions of the Indian Science Congress Association, Jaipur, Rajasthan state, India. Part II, 41-44. (Full length conference Paper). 1994.

[5] Shruthi B, Deepa N, Somashekaraiah R, Adithi G, Divyashree S, Sreenivasa MY. Exploring biotechnological and functional characteristics of probiotic yeasts: A review. Biotechnology Reports. 2022; 34: e00716.

[6] Gil-Rodríguez AM, Carrascosa AV, Requena T. Yeasts in foods and beverages: In vitro characterisation of probiotic traits, LWT - Food Science and Technology. 2015; 64: 1156–1162, https://doi.org/10.1016/j.lwt.2015.07.042.

[7] Czerucka D, Piche T, Rampal P. Review article: Yeast as probiotics - *Saccharomyces boulardii*, Aliment. Pharmacol. Ther. 2007; 26: 767–778. https:// doi.org/10.1111/j.1365-2036.2007.03442.x..

[8] Liu GL, Chi Z, Wang GY, Wang ZP, Li Y, Chi ZM. Yeast killer toxins, molecular mechanisms of their action and their applications, Crit. Rev. Biotechnol. 2015; 35: 222–234. https://doi.org/10.3109/07388551.2013.833582.

[9] Kelesidis T, Pothoulakis C. Efficacy and safety of the probiotic *Saccharomyces boulardii* for the prevention and therapy of gastrointestinal disorders, Therap Adv Gastroenterol 5 (2012) 111–125, https://doi.org/10.1177/1756283X11428502.

[10] Mcfarland LV. The Microbiota in Gastrointestinal Pathophysiology Common Organisms and Probiotics: *Saccharomyces boulardii*. 2017. 10.1016/B978-0-12- 804024-9/00018-5.

[11] Plaza-Diaz J, Ruiz-Ojeda FJ, Gil-Campos M, Gil A. Mechanisms of Action of Probiotics. Advances in Nutrition, Oxford University Press. 2019, pp. S49–S66, https://doi.org/10.1093/advances/nmy063.

[12] Bajaj BK, Claes IJJ, Lebeer S. Functional mechanisms of probiotics. Journal of Microbiology, Biotechnology and Food Sciences. 2015; 04: 321–327. https://doi. org/10.15414/jmbfs.2015.4.4.321-327.

[13] Pais P, Almeida V, Yılmaz M, Teixeira MC. *Saccharomyces boulardii*: What makes it tick as successful probiotic? Journal of Fungi. 2020; 6: 1–15. https://doi. org/10.3390/jof6020078.

[14] Khatri I, Tomar R, Ganesan K, Prasad GS, Subramanian S. Complete genome sequence and comparative genomics of the probiotic yeast *Saccharomyces boulardii*, Sci. Rep. 2017; 7. https://doi.org/10.1038/s41598-017-00414-2.

[15] Fietto JLR, Araújo RS, Valadao FN et al., Molecular and physiological comparisons between *Saccharomyces cerevisiae* and *Saccharomyces boulardii*. Can. J. Microbiol. 2004;50: 615–621, https://doi.org/10.1139/w04-050.

[16] Kaur IP, Kuhad A, Garg A, Chopra K. Probiotics: delineation of prophylactic and therapeutic benefits. J. Med. Food. 2009; 12: 219–235, https://doi.org/10.1089/ jmf.2007.0544.

[17] van der Aa Kühle A, Skovgaard K, Jespersen L. In vitro screening of probiotic properties of *Saccharomyces cerevisiae* var. *boulardii* and food-borne *Saccharomyces cerevisiae* strains. Int. J. Food Microbiol. 2005; 101: 29–39.

[18] Simoes LA, A. Cristina de Souza A, Ferreira I, Melo DS, Lopes LAA, Magnani M, Schwan RF, Dias DR. Probiotic properties of yeasts isolated from Brazilian fermented table olives. J. Appl. Microbiol. 2021; 131: 1983–1997. https://doi.org/ 10.1111/jam.15065.

[19] Fern´andez-Pacheco P, García-B´ejar B, Jim´enez-del Castillo M. et al., Potential probiotic and food protection role of wild yeasts isolated from pistachio fruits (*Pistacia vera*). J. Sci. Food Agric. 2021; 101: 2201–2209, https://doi.org/10.1002/jsfa.10839.

[20] Psomas E, C. Andrighetto C. et al., Some probiotic properties of yeast isolates from infant faeces and Feta cheese, 2001. www.elsevier.comrlocaterijfoodmicro.

[21] Fernandez-Pacheco P, Cueva C, Ar´evalo-Villena M et al., *Saccharomyces cerevisiae* and *Hanseniaspora osmophila* strains as yeast active cultures for potential probiotic applications, Food and Function. 2019; 10: 4924–4931,. https://doi.org/10.1039/c9fo00732f.

[22] Fadda ME, Mossa V, Deplano M, Pisano MB, Cosentino S. In vitro screening of Kluyveromyces strains isolated from Fiore Sardo cheese for potential use as probiotics, LWT-Food Science and Technology. 2017; 75 100–106. https://doi. org/10.1016/j.lwt.2016.08.020.

[23] Kumura H, Tanoue Y, Tsukahara M, Tanaka T, Shimazaki K. Screening of dairy yeast strains for probiotic applications. J. Dairy Sci. 2004; 87: 4050–4056. https:// doi.org/10.3168/jds.S0022-0302(04)73546-8.

[24] Probiotics and prebiotics: What you should know - Mayo Clinic.

[25] What Are Probiotics? Probiotic Supplements, Foods, Uses, Benefits, and Safety (webmd.com).

[26] Sanders ME. Probiotics in 2015: their scope and use. J. Clin Gastroenterol. 2015;49 Suppl 1:S2-6.

[27] Sanders ME. Clinical use of probiotics: what physicians need to know. Am Fam Physician. 2008;78:1026.

[28] Huang R, Ning H, Shen M, Li J, Zhang J, Chen X. Probiotics for the treatment of atopic dermatitis in children: A systematic review and meta-analysis of randomized controlled trials. Front Cell Infect Microbiol. 2017;7:392.

[29] Zhao M, Shen C, Ma L. Treatment efficacy of probiotics on atopic dermatitis, zooming in on infants: A systematic review and meta-analysis. Int J. Dermatol 2018;57:635-41.

[30] Guarino A, Ashkenazi S, Gendrel D, Lo Vecchio A, Shamir R, Szajewska H, et al. European Society for Pediatric Gastroenterology, Hepatology, and Nutrition/European Society for Pediatric Infectious Diseases evidence-based guidelines for the management of acute gastroenteritis in children in Europe: update 2014. J. Pediatr Gastroenterol Nutr. 2014;59:132-52.

[31] Collinson S, Deans A, Padua-Zamora A, Gregorio GV, Li C, et al. Probiotics for treating acute infectious diarrhoea. Cochrane Database Syst Rev. 2020;12:Cd003048.

[32] Szajewska H, Skorka A, Ruszczynski M, Gieruszczak-Bialek D. Meta-analysis: Lactobacillus GG for treating acute gastroenteritis in children--updated analysis of randomised controlled trials. Aliment Pharmacol Ther. 2013;38:467-76.

[33] Feizizadeh S, Salehi-Abargouei A, Akbari V. Efficacy and safety of *Saccharomyces boulardii* for acute diarrhea. Pediatrics. 2014;134:e176-91.

[34] Szajewska H, Guarino A, Hojsak I, Indrio F, Kolacek S, Shamir R, et al. Use of probiotics for management of acute gastroenteritis: a position paper by the ESPGHAN Working Group for Probiotics and Prebiotics. J Pediatr Gastroenterol Nutr. 2014;58:531-9.

[35] Allen SJ, Martinez EG, Gregorio GV, Dans LF. Probiotics for treating acute infectious diarrhoea. Cochrane Database Syst Rev. 2010:CD003048.

[36] Szajewska H, Berni Canani R, Domellöf M, Guarino A, Hojsak I, et al. Probiotics for the Management of Pediatric Gastrointestinal Disorders: Position Paper of the ESPGHAN Special Interest Group on Gut Microbiota and Modifications. J Pediatr Gastroenterol Nutr. 2023;76:232-47.

[37] Su GL, Ko CW, Bercik P, Falck-Ytter Y, Sultan S, et al.. AGA clinical practice guidelines on the role of probiotics in the management of gastrointestinal disorders. Gastroenterology. 2020; 159: 697-705.

[38] Ki Cha B, Mun Jung S, Hwan Choi C, Song ID, Woong Lee H, Joon Kim H, et al. The effect of a multispecies probiotic mixture on the symptoms and fecal microbiota in diarrhea-dominant irritable bowel syndrome: a randomized, double-blind, placebo-controlled trial. J Clin Gastroenterol. 2012;46:220-7.

[39] Silverman MA, Konnikova L, Gerber JS. Impact of antibiotics on necrotizing enterocolitis and antibiotic-associated diarrhea. Gastroenterol Clin North Am. 2017;46:61-76.

[40] Blaabjerg S, Artzi DM, Aabenhus R. Probiotics for the prevention of antibiotic-associated diarrhea in outpatients-a systematic review and meta-analysis. Antibiotics (Basel) 2017;6.

[41] Szajewska H, Kołodziej M. Systematic review with meta-analysis: Lactobacillus rhamnosus GG in the prevention of antibiotic-associated diarrhoea in children and adults. Aliment Pharmacol Ther. 2015;42:1149-57.

[42] Szajewska H, Kolodziej M. Systematic review with meta-analysis: *Saccharomyces boulardii* in the prevention of antibiotic-associated diarrhoea. Aliment Pharmacol Ther. 2015;42:793-801.

[43] Underwood MA. Probiotics and the prevention of necrotizing enterocolitis. J Pediatr Surg. 2019;54:405-12.

[44] Sharif S, Meader N, Oddie SJ, Rojas-Reyers, mX, McGuire W. Probiotics to prevent necrotizing enterocolitis in very preterm infants or very low birth weight infants. Cochrane Database Syst Rev. 2023:CD005496.

[45] Preidis GA, Weizman AV, Kashyap PC Morgan RL. AGA technical review on the role of probiotics in the management of gastrointestinal disorders. Gastroenterology. 2020; 159: 708-38.

[46] Wang Y, Florez ID, Morgan RL, Foroutan F, Chang Y, et al.. Probiotics, Prebiotics, Lactoferrin, and Combination Products for Prevention of Mortality and Morbidity in Preterm Infants: A Systematic Review and Network Meta-Analysis. JAMA Pediatr. 2023 Oct 2:e233849.

[47] Derikx LA, Dieleman LA Hoentjen F. Probiotics and prebiotics in ulcerative colitis. Best Pract Res Clin Gastroenterol. 2016; 30: 55-7.

[48] Wilkins T Sequoia J. Probiotics for gastrointestinal conditions: a summary of the evidence. Am Fam Physician. 2017; 96: 170-8.

[49] American Gastroenterological Association. Consideration for use of probiotics in gastrointestinal diseases: clinical decision support tool. Gastroenterology. 2020; 159: 706.

[50] Staudacher HM, Whelan K. Altered gastrointestinal microbiota in irritable bowel syndrome and its modification by diet: probiotics, prebiotics and the low FODMAP diet. Proc Nutr Soc. 2016;75:306-18.

[51] Zhuang X, Xiong L, Li L, Li M, Chen M. Alterations of gut microbiota in patients with irritable bowel syndrome: A systematic review and meta-analysis. J Gastroenterol Hepatol. 2017;32:28-38.

[52] Ford AC, Quigley EM, Lacy BE, Lembo AJ, Saito YA, Schiller LR, et al. Efficacy of prebiotics, probiotics, and synbiotics in irritable bowel syndrome and chronic idiopathic constipation: systematic review and meta-analysis. Am J Gastroenterol. 2014;109:1547-61.

[53] Didari T, Mozaffari S, Nikfar S, Abdollahi M. Effectiveness of probiotics in irritable bowel syndrome: Updated systematic review with meta-analysis. World J Gastroenterol 2015;21:3072-84.

[54] Principi N, Cozzali R, Farinelli E, Brusaferro A, Esposito S. Gut dysbiosis and irritable bowel syndrome: The potential role of probiotics. J Infect. 2018;76:111-20.

[55] Kumar R, Grover S, Batish VK. Bile salt hydrolase (Bsh) activity screening of *lactobacilli*: in vitro selection of indigenous Lactobacillus strains with potential bile salt hydrolysing and cholesterol-lowering ability. Probiotics Antimicrob Proteins. 2012;4:162-72.

[56] Bosch M, Fuentes MC, Audivert S, Bonachera MA, Peiro S, Cune J. Lactobacillus plantarum CECT 7527, 7528 and 7529: probiotic candidates to reduce cholesterol levels. J Sci Food Agric. 2014;94:803-9.

[57] Ishimwe N, Daliri EB, Lee BH, Fang F, Du G. The perspective on cholesterol-lowering mechanisms of probiotics. Mol Nutr Food Res. 2015;59:94-105.

[58] Cho YA, Kim J. Effect of probiotics on blood lipid concentrations: a meta-analysis of randomized controlled trials. Medicine (Baltimore). 2015;94:e1714.

[59] Khalesi S, Bellissimo N, Vandelanotte C, Williams S, Stanley D, Irwin C. A review of probiotic supplementation in healthy adults: helpful or hype? Eur J Clin Nutr. 2019;73:24-37.

[60] Davis CD. The gut microbiome and its role in obesity. Nutr Today. 2016;51:167-74.

[61] Borgeraas H, Johnson LK, Skattebu J, Hertel JK, Hjelmesaeth J. Effects of probiotics on body weight, body mass index, fat mass and fat percentage in subjects with overweight or obesity: a systematic review and meta-analysis of randomized controlled trials. Obes Rev. 2018;19:219-32.

[62] Hempel S, Newberry S, Ruelaz A, Wang Z, Miles JN, et al. Safety of probiotics used to reduce risk and prevent or treat disease. Evid Rep Technol Assess (Full Rep). 2011:1-645.

[63] Didari T, Solki S, Mozaffari S, Nikfar S, Abdollahi M. A systematic review of the safety of probiotics. Expert Opin Drug Saf. 2014;13:227-39.

[64] Borriello SP, Hammes WP, Holzapfel W, Marteau P, Schrezenmeir J, Vaara M, et al. Safety of probiotics that contain lactobacilli or bifidobacteria. Clin Infect Dis. 2003;36:775-80.

[65] Cohen PA. Probiotic safety--no guarantees. JAMA Intern Med. 2018;178:1577-8.

[66] Hajela N, Nair GB, Ramakrishna BS, Ganguly NK. Probiotic foods: Can their increasing use in India ameliorate the burden of chronic lifestyle disorders? Indian J Med Res. 2014 ;139(1):19-26.

[67] Czerucka D, Rampal P. Diversity of *Saccharomyces boulardii* CNCM I-745 mechanisms of action against intestinal infections, World J. Gastroenterol. 2019; 25 2188–2203. https://doi.org/10.3748/wjg.v25.i18.2188.

[68] Somashekaraiah R, Shruthi B, Deepthi BV, Sreenivasa MY. Probiotic properties of lactic acid bacteria isolated from neera: A naturally fermenting coconut palm nectar, Front Microbiol. 2019; 10. https://doi.org/10.3389/fmicb.2019.01382.

[69] Amorim JC, Piccoli RH, Duarte WF. Probiotic potential of yeasts isolated from pineapple and their use in the elaboration of potentially functional fermented beverages, Food Res. Int. 2018; 107: 518–527. https://doi.org/10.1016/j. foodres.2018.02.054.

[70] Kumura H, Tanoue Y, Tsukahara M, Tanaka T, Shimazaki K. Screening of dairy yeast strains for probiotic applications, J. Dairy Sci.2004; 87: 4050–4056.https:// doi.org/10.3168/jds.S0022-0302(04)73546-8.

[71] Kabeerdoss J, Ferdous S, Balamurugan R, Mechenro J, Vidya R, Santhanam S, *et al*. Development of the gut microbiota in southern Indian infants from birth to six months: A molecular analysis. J. Nutr Sci. 2013; *2* : 1-7.

[72] Lodder J. Microorganisms: *The Yeasts*. A Taxonomic Study. J. Lodder, Ed. Second edition. North-Holland, Amsterdam, 1970. xvi, 1386 pp.,

[73] Barnett JA, Payne RW, Yarrow D. Yeasts: Characteristics and identification. Cambridge University Press, Cambridge (1983).

[74] Wickerham, J. Tropical Med. Hyg., 42, 176 (1939).

[75] Wickerham, U.S. Dept. Agric. Tech. Bull. No. 1029 (1951)