World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(REVIEW ARTICLE)

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Kefir-A Natural Fermented Probiotic-An Updated Review

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World Journal of Advanced Research and Reviews, 2025, 28(01), 2286–2299

Publication history: Received on 10 September 2025; revised on 20 October 2025; accepted on 25 October 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.28.1.3640

Abstract

Kefir, the traditional beverage, is now recognized as a potential source of probiotics and molecules with highly interesting healthy properties. These grains are a reusable starter for a continuous fermentation cycle. Kefir grains are hard granules resembling cauliflower florets in appearance that vary from 0.3 to 3.5 cm in size. The microorganisms in the kefir grains produce lactic acid, antibiotics and bactericides, which inhibit the development of degrading and pathogenic microorganisms in kefir milk. Based on the fermenting substrate, kefir is categorized as dairy (milk) and non-dairy (water). In kefir grains the main polysaccharide is **Kefiran**, which is a heteropolysaccharide composed by equal proportions of glucose and galactose and is mainly produced by *Lactobacillus kefiranofaciens.* The kefir market consists of sales of kefir grains, kefir milk, kefir yogurt, kefir smoothie, kefir probiotic drink. Kefir's has a remarkable antimicrobial, anti-inflammatory, anticancer, antioxidant, and anti-diabetic properties attributed to the synergistic effect of kefir peptides, immune and cytokine modulatory properties and free radical scavenging effects.

Keywords: Anti-Cancer; Antioxidant; Kefir; Milk Kefir; Kefiran; *Lactobacillus kefiranofaciens*; Probiotics; Water Kefir

1. Introduction

Kefir is a naturally fermented milk drink with rich probiotic content [1-67-108-150]. Among the emerging functional foods, probiotic-based foods and beverages are becoming one of the most acceptable to consumers [1-43-108]. Traditionally, fermented foods have been shown to contain probiotic microorganisms [1-70]. Probiotics are defined as live microorganisms which when administered in adequate quantity confer health benefits to the host [67-73]. Probiotic bacteria, generally incorporated into fermented dairy products, mainly belong to the genera *Lactobacillus* and *Bifidobacterium* [67-73]. One of the important criteria used for the selection of probiotic microorganisms must be able to survive in the gastrointestinal environment and to present at least one beneficial function (colonization resistance, immunomodulation or nutritional contribution) [67-73]. In other words,probiotics are defined as food or pharmaceutical preparations containing live non-pathogenic microorganisms which improve one of the three main beneficial functions (colonization resistance, immunomodulation or nutritional contribution) of the normal gastrointestinal microbiota, when ingested by human or animal hosts [67-73-150]. The gut microbiome refers to the vast community of microorganisms, including bacteria, viruses, fungi, and other microbes, that live in the digestive tract [67-73-108-150]. This complex ecosystem plays a vital role in human health, influencing digestion, immune function, and even brain health [67-73-108-150].

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Kefir grains are not actual grains, but a living culture of yeast [145-147] and bacteria that look like small, soft, white cauliflower florets [1-67-108]. They are used to ferment milk into a tangy, probiotic drink called kefir by breaking down the lactose and producing lactic acid [1-67-108-150]. These grains are a reusable starter for a continuous fermentation cycle. Kefir grains are hard granules resembling cauliflower florets in appearance that vary from 0.3 to 3.5 cm in size [1-65-99-150]. Traditionally, kefir is manufactured using cow, goat, camel, donkey and buffalo milk [1-40-108]. Milk kefir grains are small white gelatinous balls that visually resemble small cauliflowers clumped together[1-50]. Kefir, the traditional beverage, is now recognized as a potential source of probiotics and molecules with highly interesting healthy properties[1-40-108-150]. Kefir is an acidic-alcoholic fermented milk product with little acidic taste and creamy consistency that was originated in the Balkans, in Eastern Europe, and in the Caucasus [1-67]. Kefir is an acid-alcoholic fermented milk drink that has been consumed since ancient times in The Caucasus mountains regions of Asia [1-67-108-150].

According to the study conducted by Azhar and Munaim (2019) [67], the majority of the bacterial and yeast strains that can be found in the kefir drink in Malaysia are *Lactobacillus* and *Saccharomyces* that are recognized as probiotic microorganisms [67]. In Malaysia, Kefir drink is a product from the fermentation process of milk using symbiotic mixture of bacteria and yeast consortium [67]. *Saccharomyces* and *Lactobacillus* are the major genera found in the kefir drink [67]. Kefir drink is a product that undergoes a fermentation process using milk as a medium [67]. The taste is quite acidic and it has a creamy-like texture [67]. It is normally produced from a traditional kefir grains or kefir starter cultures by fermentation process [67]. Tingirikari et al., (2024) [9] reported that Kefir comprises a microbial symbiotic mixture of bacteria and yeast that attached to a polysaccharide matrix [9-67-108-135]. Although the bacterial population is dominant in kefir, the presence of yeast plays an important role to develop the flavors as well as chemical composition of the kefir product [67-108-150].

Kefir is creamy in texture and tastes slightly sour and acidic. It is now a widely consumed beverage worldwide, mostly in Eastern and Northern Europe and Japan[1-60-108]. The term kefir is derived from the Turkish word “keyif” meaning “good feeling”, in reference to the emotions one has after consuming the drink [1-46-108-150]. Kefir is differentiated into two main types, namely traditional and industrial kefir, based on the process of its production method[1-50]. The key difference between these methods lies in the process of inoculation of kefir grains or starter culture in the milk [1-40-108]. In the traditional method, kefir varies in microbial content and sensory properties due to its origin, storage, and handling conditions [1-57-108]. In contrast, industrial methods rely on standard starter cultures and precise environmental conditions to ensure that every batch has the same microbial content and sensory properties [1-37-108]. Traditional kefir preparation involves fermenting milk using kefir grains, a starter culture of yellowish, tiny, amorphous, and gelatinous form [1-28-108-150]. Some studies suggest that probiotic bacteria in kefir consumers’ influence gut microbiota which are abundant and are correlated with health improvement [1-93-108]. Hence, it had been demonstrated that the cell-free fraction of kefir enhances the ability to digest lactose relieving symptoms[1-73-108]. Another reason for the increased interest in probiotic strains from kefir is its capacity to lower cholesterol levels [1-43-108-150].

2. Indian Probiotic Food

Some of the top Indian probiotic foods and drinks which can have daily consumption for a healthy gut: 1. Curd (Dahi) 2. Buttermilk (Chaas) 3. Kanji Lassi. 4 Kefir milk 5. Idli / Dosa 6. Dhokla 7. Handvo 8. Appam 9. Khusha 10. Khambral (Kombucha) 11. Pickles (Achaar) 12. Sauerkraut (Homemade) 13. Pakhala / Panta Bhat 14. Fermented Soy (Tempeh/Natto) 15. Khaman 16. Fermented Porridge 17. Kimchi (Indian-style) 18. Fermented Peanut Chutney 19. Ragi Malt (Fermented) 20. Kefir grains(Homemade) [67-73]. Indian companies which are selling kefir grains include, KefirWala and indiaweightlosskefir.com [1-67]. These companies sell both water and milk kefir grains, which can be purchased online for home fermentation. Other options may include online marketplaces like Amazon India[67-73]. All these probiotic foods maintain the balance of gut bacteria, strengthen immunity, and ensure overall health, making them simple and effective inclusions in our daily diet for improved gut health [67-73].

3. International Kefir Brands

Some of the best International kefir brands [11-14] include Lifeway, Maple Hill Creamery, and Wallaby Organic for a wide variety of options, while Redwood Hill Farms and Green Valley Organics are good choices for those with sensitivities to cow's milk [11-14]. Major companies operating in the kefir market include Danone SA, Lifeway Foods Inc., Nestle SA, Fresh Made, Maple Hill Creamery LLC, The Hain Celestial Group Inc., Green Valley Organics, Wallaby Yogurt Company, Biotiful Dairy Ltd., Redwood Hill Farm & Creamery Inc., Babushka Kefir, Greek Gods Yogurt, GO-KEFIR, Nancy's Probiotic Foods, Yofix Probiotics Ltd., Grace Harbor Farms, Forager Project LLC, Rumba Kefir, Organic Meadow

Limited Partnership, Oak Knoll Dairy, Oy Elopak Ab, Latta Buildtech Private Ltd., Güvenç A.S, Kri Kri Milk Industry SA, New Age Farm Inc., One Straw Farm, Lifeway Foods Canada Inc., Granarolo S.p.A, Good Karma Foods Inc., The Icelandic Milk and Skyr Corporation, and Green Mountain Creamery LLC [11-14].

4. Kefir Production

Kefir can be produced through diverse methodologies, including: (1) traditional manufacturing, entailing the fermentation of milk with kefir grains; (2) a Russian or European approach; and (3) industrial-scale production, wherein kefir is fermented by the direct incorporation of commercial starter cultures into milk. Kefir can be produced by fermenting milk with commercial freeze-dried kefir starter cultures, traditional kefir grains, and the product that remains after the removal of kefir grains [1-73-108-135]. Kefir grains are a kind of yogurt starter, which are white to yellow – white, gelatinous, and variable in size (varying from 0.3–3.5 cm in diameter) and are composed by a microbial symbiotic mixture of lactic acid bacteria (108 CFU/g), yeast (106–107 CFU/g), and acetic acid bacteria (105 CFU/g) that stick to a polysaccharide matrix [1-69-108-150]. After successive fermentations, kefir grains can break up to new generation grains, which have the same characteristics as the old ones [1-73-108-135]. These grains are used to turn milk into milk kefir, a fermented drink that is full of probiotics and is said to have many health benefits[1-73]. These strange little clumps house a jungle of beneficial bacteria and yeast that live in symbiosis and are activated when mixed with milk to create creamy, tangy, and slightly fizzy milk kefir [1-73-150]. Once the kefir has been produced, the grains can be collected and put into fresh milk to start a new kefir fermentation[1-73]. Kefir grains are the living symbiotic colonies of yeast and bacteria that convert milk into the probiotic powerhouse that is milk kefir[1-73-135]. As the kefir grains digest the lactose in the milk, they create that tangy, creamy taste and texture that makes milk kefir[1-73-108-135-150].

In addition, *Bifidobacterium* sp., *Lactobacillus* sp. and probiotic yeast (*Saccharomyces boulardii*) may be used as adjunct cultures when blended with kefir grains or kefir DVI cultures [1-73-150]. On the other hand, whey may be a practical base for kefir culture production, and fermented whey has shown to be a suitable cryoprotective medium during freeze-drying[1-73-108]. The consumption of this fermented milk has been related to a variety of health benefits. Kefir may not only be a natural probiotic beverage, but also acts as an effective matrix for the delivery of probiotic microorganisms[1-73-108-150]. Due to its composition, kefir is mainly considered a probiotic resource [1-73-108-135].

These grains are usually composed of diverse combinations of bacterial species, including lactic acid bacteria (108 CFU/g) such as *Lactobacillus, Lactococcus, Leuconostoc, Pediococcus, Carnobacterium*, and acetic acid bacteria (105 CFU/g) such as *Acetobacter cerevisiae, Acetobacter pasteurianus*, and yeast (104–106 CFU/g) [1-67-108]. Kefir grains are kept viable by maintaining a high bacteria–yeast ratio, which is accomplished by ongoing fermentation cycles that increase the biomass of grains depending on different factors, such as pH, temperature, washing, milk renewal, and availability of nutrients [1-69-108-150]. After a series of successful fermentation processes, kefir grains divide into new grains with the same microbial traits as the originals [1-68-108-150]. To produce kefir in household conditions, kefir grain preservation can be accomplished either by continuous fermentation cycles or 10 weeks of multiplication of biomass growth [1-73]. Some studies have shown that kefir grains and fermentation time directly impact the properties of the drink. Kefir grain concentrations of 3–5% were found to be optimal for yielding the lactic acid bacteria and protein levels [1-73-108-150]. Additionally, 18 h, 21 h, and 24 h fermentation times have been known to change the intensity of microbial activity and chemical composition of milk, which can influence the quality of the end product [1-73-108-150].

5. Types of Kefir

Based on the fermenting substrate, kefir is categorized as dairy (milk) and non-dairy (water) [1-59-108-150]. However, milk and water kefir grains are traditionally blended with a vast symbiotic microbial consortiums and exhibit striking similarities in terms of characteristic structure, associated microbial composition, and metabolites [1-70-108-150]. Milk kefir yields substantial quantities of protein, probiotics, and prebiotics[1-59-108-135-150]. In contrast, water kefir emerges as a crucial reservoir of probiotics, prebiotics, and antioxidants, particularly catering to the dietary needs of vegans and individuals with dairy allergies or intolerances [1-59-108-150]. Both milk and water kefir are produced through the inoculation of the kefir grain as starter culture into sub strates (milk or water-based solutions enriched with fruits, vegetables, and sugar sources) at variable proportions (ranging up to 20% w/v) and fermenting for 24 h at a varying temperature of 20–40 °C [1-70-108-150]. Upon completion of the fermentation, kefir grains are then separated from the beverage through filtration and can be reused for subsequent inoculations [1-38-108-150]. In dairy Kefir, milk sourced from various ruminants (cows, sheep, goats, buffalo, or camels, donkey) serves as a substrate for

fermentation [1-56-108-150]. Milk kefir is a cultured dairy product obtained from the symbiotic interaction between kefir grains and milk, resulting in a fermented beverage [1-60-108]. The granular composition of milk kefir is characterized by small, creamy, yellowish-to-white structures resembling cauliflower florets in an irregular and lobed shape, with a diameter ranging between 0.1 and 0.2 cm [1-47-108-135-150]. The characteristic microbiota in milk kefir comprises *Lactobacillus kefiranofaciens, Lactobacillus. kefiri, Lactobacillus. parakefiri*, and *Lactobacillus kefirgranum* [1-49-108-135]. LAB are introduced into milk to initiate the process [1-67-108-150]. These microorganisms enzymatically convert lactose into lactic acid, leading to a reduction in pH. Thus, LAB influence the sensory attributes and extended shelf life of fermented milk [1-46-108-150].

On the other hand, water kefir grains are fermented with water substrate in a saccharine medium, with brown sugar serving as a primary substrate, whereas other auxiliary substrates include fruit juices (e.g., grape, pomegranate, apple, pineapple, and melon), vegetables (e.g., onion, ginger, soybean, and carrot), and molasses (e.g., honey, sugarcane) [1-26, 27-70-108-135]. Water kefir grains, are also known as "Tibi or Tibico," "Sugary kefir grains," "Japanese water crystals," and "Graines Vivantes," contain a dextran matrix [1-49-108-135]. The predominant microbiota accountable for the synthesis of the dextran structure in water kefir grains includes *Lactobacillus* sp. *Lactobacillus casei*, *Lactobacillus nagelii, Lactobacillus hilgardii, Lactobacillus hordei*, and *Leuconostoc mesenteroides* [1-50–54-67-108]. The fermentation process of non-dairy (water) kefir is facilitated by kefir grains, which comprise a conglomerate of acetic acid bacteria, yeast, predominantly *Saccharomyces, Candida*, and *Kluyveromyces,* as well as LAB, encompassing the species, *Leuconostoc, Lactobacillus, Streptococcus, Oenococcus, Pediococcus, Enterococcus,* and *Lactococcus* [1-67-108-150]. Water kefir harbours an estimated composition of around 70–75% L*actobacillus* sp., 10–12% *Leuconostoc* sp., 8–10% *Acetobacter* sp., 5–7% *Bifidobacterium* sp., and 3–5% other bacterial species, and as compared to dairy kefir, water kefir nurtures more genera of yeast (like species of *Guehomyces, Kloeckera*, and *Hanseniaspora*) [1-60-108-150].

6. Microbial Composition of Kefir grains

In recent decades, a global shift in lifestyle and the ubiquitous consumption of junk foods have led to dysbiosis and other metabolic disorders significantly impacting human health [1-9-108-150]. Recent studies performed on traditional foods have shown several health benefits and have gained the attention of the scientific community towards ethnic foods [1-99-135]. In this regard, the consumption of ethnic foods with symbiotic properties is increasing gradually across the globe[1-90]. Kefir is a thick, sour, and sometimes slightly spritzy fermented milk drink produced through the action of the bacteria and fungi within kefir 'grains', a classic example of a SCOBY (Symbiotic Community of Bacteria and Yeasts) [1-67-108]. The microbial diversity of kefir samples collected from a wide geographical area has been reported and discussed [1-63]. The distribution of yeast and bacteria in the Indian kefir grains, like other kefir grains, are a complex symbiotic mixture of lactic acid bacteria, yeasts, and acetic acid bacteria held together by a unique polysaccharide matrix [1-67-108-150].

The key bacterial genera include *Lactobacillus, Lactococcus, Leuconostoc*, and *Acetobacter*, while common yeasts include *Kluyveromyces* and *Saccharomyces* species [1-60-108-150]. The specific microbial composition can vary based on the grain's origin and production methods [1-68-144-150]. Kefir grains have a complex composition of microbial species such as the predominance of lactic acid bacteria, acetic bacteria, yeasts, and fungi [1-67-108]. This microbial species are classified into four groups: homofermentative and heterofermentative lactic acid bacteria and lactose and non-lactose assimilating yeast [1-63]. In that way, *Lactobacillus paracasei* ssp. *paracasei*, *Lactobacillus acidophilus*, *Lactobacillus delbrueckii* ssp. *bulgaricus*, *Lactobacillus plantarum*, and *L. kefiranofaciens* are predominant species[1-63-108-150] However, these species represent only 20% of the *Lactobacillus* in the final fermented beverage, with the remainder consisting of *Lactobacillus kefiri* (80%), *Acetobacter aceti* and *A. rasens* have also been isolated, such as the fungus *Geotrichum candidum* [1-63-108]. More than 23 different yeast species have been isolated from kefir grains and from fermented beverages of different origins [1-69-108-150]. However, the predominant species are *Saccharomyces cerevisiae, S. unisporus, Candida kefyr*, and *Kluyveromyces marxianus* ssp. *marxianus* [1-73-108-135]. There is a symbiotic relation between the microorganisms present in kefir grains, wherein the bacteria and yeast survive and share their bioproducts as power sources and microbial growth factors [1-69-103-150]. This microorganism association is responsible for lactic and alcoholic fermentation [1-73-108-150]. The microbial composition may vary according to kefir origin, the substrate used in the fermentation process and the culture maintenance methods [1-69-108-150]. Tibetan kefir, which is used in China, is composed of *Lactobacillus, Lactococcus*, and yeast. Additionally, acetic acid bacteria have been identified in Tibetan kefir, depending on the region in China from where it was obtained, Tibetan kefir composition differs from that of Russian kefir, Irish kefir, Taiwan kefir, Turkey fermented beverage with kefir [1-63-106-150]. However, it is known that this microbial diversity is responsible for the physicochemical features and biological activities of each kefir [1-69-108-150].

7. Chemical Activity of Kefir

On the basis of literature survey, probiotics present in milk kefir generate different chemical metabolites that have hypocholesterolemic, antimicrobial, antihypertensive, anti-inflammatory, antioxidant, and anticarcinogenic actions and are generally beneficial to human health [1-67-108-150]. Kefir has been shown to possess antibacterial properties against a variety of microbes [1-57-135-150].

The microorganisms in the kefir grains produce lactic acid, antibiotics and bactericides, which inhibit the development of degrading and pathogenic microorganisms in kefir milk [1-68-108-135-150]. Kefir acts against the pathogenic bacteria *Salmonella, Helicobacter, Shigella, Staphylococcus, Escherichia coli, Enterobacter aerogenes*, *Proteus vulgaris, Bacillus subtilis, Micrococcus luteus, Listeria monocytogenes, Streptococcus pyrogenes, Streptococcus faecalis* KR6, *Fusarium graminearum* CZ1, and the fungus *Candida albicans* [1-69-108-135-150]. On the other hand, it has been demonstrated that a mixture of kefir isolated bacteria and yeast is able to prevent diarrhea and enterocolitis triggered by Clostridium difficile [1-608-108-150]. Besides, kefir showed good efficacy in inhibiting spore formation and aflatoxin B1 produced by the fungus *Aspergillus flavus*, which is a toxic compound formed either in the field or during food storage[1-69-108]. Therefore, kefir appears as a promising safe alternative natural food preservative offering protection against intoxication with aflatoxin B1[1-67-108-150]. It had been proved that many species of lactobacilli present in kefir have S-layer proteins. Surface layers (S-layers) can be aligned in unit cells on the outermost surface of many prokaryotic microorganisms [1-67-108-150]. It has been demonstrated that these S-layer proteins can apply a protective action inhibiting the grown of *Salmonella enterica serovar Enteritidis* in Caco-2 cells, and also have the ability to antagonize the effects of toxins from *Clostridium difficile* on eukaryotic/eukaryotic cells *in vitro* [1-67-108-150]. However, there are other important bioactivities that have been tested with kefir grains, the cell-free fraction of kefir or acid lactic bacteria isolated from kefir, such as antitumoral, anti-inflammatory, antimicrobial immunoregulatory, antiallergenic, wound healing, antidiabetic, antimutagenic and antigenotoxic [1-67-108-135]. Hence, it had been demonstrated that kefir cell-free fraction has antiproliferative effects on human gastric cancer SGC7901 cells, colon adenocarcinoma cells, HuT–102 malignant T lymphocytes, sarcoma 180 in mice, Lewis lung carcinoma and human mammary cancer , and reduce oxidative stress [1-67-108-144-150]. Another study has shown that suspensions after 24 h fermentation and mechanically disintegrated kefir grains cause a significant inhibition of granuloma tissue formation and a 43% inhibition of the inflammatory process [1-67-108-150].

The increased search for natural polysaccharides has been very significant due to their use in the food, pharmaceutical, and cosmetic industries as additives, bio-absorbents, metal removal agents, bioflocculants, and medicine delivery agents, among other functions [1-67-108-150]. Many microorganisms, such as bacteria, fungi, and weeds, have the capacity/ability to synthesize and excrete extracellular polysaccharides, and these polysaccharides can be either soluble or insoluble [1-67-108-150]. The polysaccharides that are commonly used as food additives are xanthan, dextran, gellan, and alginates, while the exopolysaccharides (EPSs) produced by lactic acid bacteria show good physicochemical characteristics for their use as food additives [1-67-108-150]. In addition to these characteristics, EPSs are obtained from microorganisms classified as GRAS (generally recognized as safe), such as lactic acid bacteria [1-67-108-135-150].

The EPS kefiran is produced by *Lactobacillus kefiranofaciens* from kefir grains, which are composed of proteins, polysaccharides, and a complex symbiotic microbial mixture [1-67-108-150]. These microorganisms grow in kefiran, which is a polysaccharide matrix consisting of glucose and galactose [1-67-108-135-150]. Despite good kefiran production by *L. kefiranofaciens* alone, it has been observed that the addition of *Saccharomyces* sp. to the culture improves the net quantity of kefiran, illustrating the importance of the symbiosis between the bacteria and yeast that are present in kefir [1-57-108-150]. actic acid bacteria can synthesize homopolysaccharides or heteropolysaccharides[1-67-135]. The synthesized homopolysaccharides are glucans or fructans, which are composed of only one type of monosaccharide (glucose or fructose, respectively), whereas the heteropolysaccharides contain different types of monosaccharides in different proportions (mainly glucose, galactose, and rhamnose), [1-67-108-150].

Similarly to lactic acid bacteria, *Lactobacillus* sp. also produces glucan and fructan [1-67-108-150]. The homopolysaccharides show a much higher performance compared with heteropolysaccharide production [1-67-108]. The heteropolysaccharides excreted by *Lactobacillus delbrueckii, Lactobacillus bulgaricus, Lactobacillus rhamnosus*, and *Lactobacillus helveticus* contain galactose, glucose, and rhamnose as the main monosaccharides, with other monosaccharides being present in smaller concentrations[1-67-107-150]. They are also highly branched with different types of linkages, and their denominations are complex and generally dependent on the main monosaccharide[1-67-108-150].

Lactobacillus plantarum isolated from Tibetan kefir excretes EPS classified as heteropolysaccharides composed of galactose, glucose, and mannose [1-67-108-150]. This EPS has the capacity/ability to reduce blood cholesterol and form

a biofilm shape [1-67-108-150]. Kefiran is an EPS classified as a heteropolysaccharide comprising glucose and galactose in high concentrations, and it is classified as a water-soluble glucogalactan, which makes it suitable to be used as an additive [1-67-106]. Kefiran has excellent rheological properties and can significantly improve the viscosity of lacteous products by favoring and maintaining gel properties and avoiding the loss of water during storage [1-67-108-135]. With respect to the biological activity of kefiran, several studies have demonstrated that this EPS can be used as a nutraceutical [1-67-107-150].

8. The Polysaccharide Kefiran

In kefir grains, the main polysaccharide is kefiran, which is a heteropolysaccharide composed by equal proportions of glucose and galactose and is mainly produced by *Lactobacillus kefiranofaciens* [1-67-108-144-150]. It has been demonstrated that kefiran improves the viscosity and viscoelastic properties of acid milk gels, and is able to form gels that have interesting viscoelastic properties at low temperatures [1-67-108-150]. Therefore, kefiran can also be used as an additive in fermented products [1-67-108]. Besides, kefiran can enhance the rheological properties of chemically acidified skim milk gels increasing their apparent viscosity[1-47-108-150]. Compared with other polysaccharides, kefiran has outstanding advantages such as antitumor, antifungal, antibacterial properties immunomodulation or epithelium protection, anti-inflammatory, healing, and antioxidant activity [1-67-108]. Kefir refers to a fermented milk drink made from kefir grains, which are a combination of bacteria and yeast [1-67-108-144-150]. This probiotic beverage has a tangy flavor and a creamy texture, similar to yogurt but usually thinner [1-67-108-135]. It is rich in beneficial probiotics, vitamins, and minerals, and is known for its potential health benefits, including improved digestion and immune support [1-67-108, 144-150]. It can be consumed on its own or used in smoothies, salad dressings, and various recipes[1-97]. For further insights on this market, Kefir grains offer numerous health benefits, including boosting the immune system, alleviating digestive issues, and enhancing antimicrobial activity [1-67-108-144-150]. They are rich in beneficial probiotic bacteria that promote gut health and support a balanced intestinal microbiota [1-67-108]. "Beta-lactoglobulin (β-lg), a well-known milk protein," is used to create nanofibril structures that can serve as scaffolds [1-67-108-144-150]. Kefiran, the EPS of kefir, has very important physicochemical and rheological properties. Besides, its biological properties suggest its use as antioxidant, antitumor agent, antimicrobial agent, and immunomodulator [1-67-108-150].

9. Health Benifits of Kefir

Due to changes in lifestyle and food behavior, the global burden of diseases is increasing, significantly affecting human health leading to dysbiosis and several metabolic and non-metabolic-related disorders [1-65-108-150]. In the past decade, functional foods have gained considerable attention from the scientific community[1-65-108]. The exploration of both dairy and water kefir, their production methodologies, and their microbial compositions has provided valuable insights into the diversity of this ethnic fermented beverage[1-45-108-135-150]. Unlike traditional dairy kefir, non-dairy kefir is highly suitable for individuals with lactose intolerance, vegan dietary preferences, or dairy allergies [1-35-108-144]. Furthermore, compelling evidence supports kefir's remarkable antimicrobial, anti-inflammatory, anticancer, antioxidant, and anti-diabetic properties attributed to the synergistic effect of kefir peptides, immune and cytokine modulatory properties and free radical scavenging effects[1-65-108-150].

The antimicrobial efficacy of kefir is attributed to the presence of LAB [1-65-108]. These microorganisms actively engage in competition with pathogens for nutrients. Additionally, kefir fermentation triggers the endogenous synthesis of organic acids (specifically lactic and acetic acid), CO_2, acetaldehyde, bacteriocins, cathelicidin, and H_2O_2 [1-65-108-144]. Supplementation of kefir has been reported to reduce the glycemia and enhance the equilibrium between pro- and anti-inflammatory cytokines, as indicated by the modulation of interleukin-1(IL-1), IL-6, and the tumor necrosis factor (TNF)/IL-10 ratio [1-71-108-150]. The potential of kefir and its fractions as adjunctive components in cancer therapy has been reported [1-65-108]. Kefir exhibits robust antioxidant in both ex vivo and in situ studies model [1-65-108-144]. Probiotics present in kefir have the potential to stimulate the gut microbiota to generate insulinotropic polypeptides and glucagon-like peptide, thereby inducing glucose uptake by muscular tissues [9-65-108]. The anti-diabetic potential of kefir depends on the substrate and fermentation technique employed [9-11-67-108-144-150]. Furthermore, the glucose-lowering effect of kefir may be attributed to its antioxidant activity, that eventually contribute to the regulation of blood sugar or the reduction of glucose absorption in the gastrointestinal tract [1-67-108-150].

10. Kefir Market Reports

The kefir market size has grown strongly in recent years. It will grow from **$2.49 billion in 2024 to $2.62 billion in 2025 at a compound annual growth rate (CAGR) of 5.2%.** Kefir refers to a fermented milk drink made from kefir

grains, which are a combination of bacteria and yeast [11-14]. This probiotic beverage has a tangy flavor and a creamy texture, similar to yogurt but usually thinner [1-11-14-70]. It is rich in beneficial probiotics, vitamins, and minerals, and is known for its potential health benefits, including improved digestion and immune support[1-11-14-70]. It can be consumed on its own or used in smoothies, salad dressings, and various recipes [1-11-14-70]. The main types of kefir include milk kefir and water kefir, which are sourced from animal milk, soy milk, coconut milk and others [1-11-14-70-108]. Milk kefir refers to a fermented dairy product and is made by adding the culture to the milk and keeping it warm like yogurt [1-11-14-70-108]. Milk kefir is high in probiotics and aids digestion. The sourced from organic and conventional ingredients, and available in both flavored and unflavored categories [1-11-14-70-108]. These products are distributed through supermarkets/hypermarkets, convenience stores, specialty stores, and other distribution channels [11-14-67]. The growing popularity of functional beverages will propel the Kefir market [11-14-67]. The demand for nutrient-rich drinks, sugar-free products, and non-dairy products lead to the Kefir market growth [11-14]. Therefore, the rising demand for functional beverages will drive the kefir industry [11-14].

Drinkable kefir refers to the liquid form meant for direct consumption, while spoonable kefir is thicker and often consumed with a spoon, similar to yogurt [11-14]. For instance, in September 2024, Activia, an India-based company that operates in the fast-paced consumer goods sector, launched a new range of spoonable and drinkable kefir to enhance gut health[11-14]. A new kefir range offers both drinkable and spoonable options for gut health. Available in Natural and Strawberry & Raspberry flavors, it features 16 live culture strains to promote digestive wellness [11-14]. The kefir is enriched with calcium and crafted for a smooth texture and mild taste [11-14]. It aims to provide an accessible and enjoyable gut health experience [11-14]. North America was the largest region in the kefir market in 2024 [11-14-150]. **Asia-Pacific** is expected to be the fastest-growing region in the kefir market share during the forecast period [11-14]. The regions covered in this market report include Asia-Pacific, Western Europe, Eastern Europe, North America, South America, Middle East and Africa[11-14]. The countries covered in this market report include Australia, Brazil, China, France, Germany, India, Indonesia, Japan, Russia, South Korea, UK, USA, Italy, Spain, Canada [11-14]. Milk kefir grains are concentrated symbiotic cultures of lactic acid bacteria and yeasts [1-67-108]. Innovation is focused on improving grain viability, shelf life (particularly for dehydrated grains), and developing value-added products like flavored kefir or kefir-based drinks[1-11-14-70-108].

The kefir market consists of sales of kefir grains, kefir milk, kefir yogurt, kefir smoothie, kefir probiotic drink [1-67]. Key players in the market include Cultures for Health, Freshly Fermented, Kombucha Kamp, Happy Kombucha, Symbiota, Crafty Cultures, and Poseymom, each vying to capture a share of this burgeoning market [11-14]. The global milk kefir grain market is experiencing robust growth, driven by increasing consumer awareness of its health benefits and the rising popularity of fermented foods and beverages [11-14]. The market size in 2025 is estimated at $150 million, projecting a Compound Annual Growth Rate (CAGR) of 12% from 2025 to 2033 [11-14-108]. This significant growth is fueled by several key trends, including the increasing demand for functional foods with probiotics and prebiotics, a growing preference for natural and organic products, and the expansion of online sales channels that provide convenient access to kefir grains[11-14].

11. Conclusion

Kefir is a naturally fermented food that is rich in probiotics. Probiotics are microbial cell preparations or components of microbial cells with a beneficial effect on the health of the host. Kefir is one such ethnic food with excellent functional properties. It is a unique traditional fermented drink comprised of kefir grains and probiotic microbes. Kefir grains are a gelatinous consortium of casein, milk solids coupled with yeasts, and lactobacilli rich microbiota embedded in a polysaccharide matrix. These components act as starters, initiating fermentation when introduced into fresh milk. This beverage of symbiotic benefits, encompassing improved gut health and preventing several metabolic and other diseases through various biological mechanisms. Despite its millennia long history, it has recently gained prominence due to emerging biotechnological and nutraceutical applications. Kefir has been acknowledged as a beneficial functional food with alternative therapeutic potential, and further studies on this topic are particularly important. However, several animal and human trails need to be performed to signify the health-promoting attributes of kefir.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Prado MR, Blandón LM, Vandenberghe LP, Rodrigues C, Castro GR, Thomaz-Soccol V, Soccol CR. Milk kefir: Composition, microbial cultures, biological activities, and related products. Front Microbiol. 2015; 30;6:1177.

[2] Arslan S. A review: Chemical, Microbiological and Nutritional Characteristics of Kefir. CyTA J. Food. 2015; 13: 340–345

[3] Gul O, Mortas M, Atalar I, Dervisoglu M, Kahyaoglu T. Manufacture and Characterization of Kefir Made from Cow and Buffalo Milk, Using Kefir Grain and Starter Culture. J. Dairy Sci. 2015; 98: 1517–1525.

[4] Chadha M, Shukla R, Tiwari RK, Choudhary S, Adya A, Singh K. Optimizing the Formulation of Homemade Milk Kefir Drink from India: Comprehensive Microbial, Physicochemical, Nutritional, and Bioactivity Profiling. Eng. Proc. 2024; 67: 44.

[5] Adya A, Sharma P, Chadha M, Sunil Kumar, Singh K, Shukla R. Effect of Varying Concentration of Kefir Grains on the Microbial, Physiochemical, Antioxidant and Sensory Properties of Water Kefir Fermented Drink. BIO Web of Conferences 178, 03016 (**2025**) https://doi.org/10.1051/bioconf/202517803016 8th AMIFOST 2025.

[6] Motoshima H, Fujioka I, Uchid K. Identification of dominant species common to kefir grains from 7 origins for kefir grain reconstruction. J. Dairy Sci. 2025; 108:8222–8236.

[7] **Manjunatha** V, Bhattacharjee D, Flores C. Unlocking Innovations: Exploring the Role of Kefir in Product Development. Curr Food Sci Tech Rep. 2024*;* **2**: 221–230

[8] Farag MA, Jomaa SA, El-Wahed AA, El-Seedi AHR. The Many Faces of Kefir Fermented Dairy Products: Quality Characteristics, Flavour Chemistry, Nutritional Value, Health Benefits, and Safety. Nutrients. 2020; 28;12(2):346.

[9] **Tingirikari** JMR, Sharma A, Lee HJ. Kefir: A fermented plethora of symbiotic microbiome and health. J. Ethn. Food. 2024*;* **11**: 35.

[10] Mudoor Sooresh M, Jayawickrama A, Silva A, Nguyen S, Schmidt S, Sebastian J, Carey S, Harynuk J, Willing BP and Bourrie BCT. Fermentation of kefir with traditional freeze-dried starter cultures successfully recreates fresh culture fermented kefir. Front. Microbiol. 2025; 16:1655390.

[11] Milk Kefir Grain Analysis Report 2025: Market to Grow by a CAGR of XX to 2033, Driven by Government Incentives, Popularity of Virtual Assistants, and Strategic Partnerships.

[12] Milk Kefir Grain Analysis Report 2025: Market to Grow by a CAGR of XX to 2033, Driven by Government Incentives, Popularity of Virtual Assistants, and Strategic Partnerships (archivemarketresearch.com).

[13] **Kefir Global Market Report 2025**: By Type (Milk Kefir, Water Kefir), By Form (Organic, Conventional), By Category (Flavored kefir, Non-Flavored kefir), By Source (Animal milk, Soy milk, Coconut milk, Other Sources), By Distribution Channel (Supermarkets/Hypermarkets, Convenience Stores, Specialist Stores, Other Distribution Channels) – Impact of Tariff and Trade War on Market Size, Growth, Trends, and Forecast 2025–2034

[14] Kefir Market Report 2025: Forecast and Growth By 2034 (thebusinessresearchcompany.com).

[15] Biadała A, Adzahan NM. Storage Stability of Antioxidant in Milk Products Fermented with Selected Kefir Grain Microflora. Molecules. 2021; 26: 3307.

[16] Guangsen T, Xiang L, Jiahu G. Microbial Diversity and Volatile Metabolites of Kefir Prepared by Different Milk Types. CyTA J. Food. 2021; 19: 399–407.

[17] Gökırmaklı Ç, Güzel-Seydim ZB. Water Kefir Grains vs. Milk Kefir Grains: Physical, Microbial and Chemical Comparison. J. Appl. Microbiol. 2022; 132: 4349–4358.

[18] Hecer C, Ulusoy B, Kaynarca D. Effect of Different Fermentation Conditions on Composition of Kefir Microbiota. Int. Food Res. J. 2019; 26: 401–409.

[19] Kavas G. Kefirs Manufactured from Camel (*Camelus dramedarius*) Milk and Cow Milk: Comparison of Some Chemical and Microbial Properties. Ital. J. Food Sci. 2015; 27: 357–365.

[20] Gamba RR, Yamamoto S, Abdel-Hamid M, Sasaki T, Michihata T, Koyanagi T, Enomoto T. Chemical, Microbiological, and Functional Characterization of Kefir Produced from Cow's Milk and Soy Milk. Int. J. Microbiol. 2020; 7019286.

[21] La Torre C, Caputo P, Cione E, Fazio A. Comparing Nutritional Values and Bioactivity of Kefir from Different Types of Animal Milk. Molecules. 2024; 29: 2710.

[22] Yirmibesoglu S, Öztürk B. Comparing Microbiological Profiles, Bioactivities, and Physicochemical and Sensoryproperties of Donkey Milk Kefir and Cow Milk Kefir. Turk. J. Vet. Anim. Sci. 2020; 44: 774–781.

[23] Gentry B, Cazón P, O'Brien K. A Comprehensive Review of the Production, Beneficial Properties, and Applications of Kefiran, the Kefir Grain Exopolysaccharide. Int. Dairy J. 2023; 144: 105691.

[24] Aroua M, Ben Haj Koubaier H, Bouacida S, Ben Saïd S, Mahouachi M, Salimei E. Chemical, Physicochemical, Microbiological, Bioactive, and Sensory Characteristics of Cow and Donkey Milk Kefir during Storage. Beverages. 2023; 9: 2.

[25] Yilmaz-Ersan L, Ozcan T, Akpinar-Bayizit A, Sahin S. Comparison of Antioxidant Capacity of Cow and Ewe Milk Kefirs. J. Dairy Sci. 2018; 101: 3788–3798.

[26] Ozcan T, Sahin S, Akpinar-Bayizit A, Yilmaz-Ersan L. Assessment of Antioxidant Capacity by Method Comparison and Amino acid Characterisation in Buffalo Milk Kefir. Int. J. Dairy Technol. 2019; 72:65–73.

[27] Sabokbar N, Khodaiyan F. Characterization of Pomegranate Juice and Whey Based Novel Beverage Fermented by Kefir Grains. J. Food Sci. Technol. 2015; 52: 3711.

[28] Diosma G, Romanin DE, Rey-Burusco MF, Londero A, Garrote GL. Yeasts from Kefir Grains: Isolation, Identification, and Probiotic Characterization. World J. Microbiol. Biotechnol. 2014; 30: 43–53.

[29] Food Safety and Standards Authority of India (FSSAI): Manual of Methods of Analysis of Foods, Dairy and Dairy Products, 2nd ed.; FDA Bhawan: New Delhi, India, 2022.

[30] Azizi NF, Kumar MR, Yeap SK, Abdullah JO, Khalid M, Omar AR, Osman MA, Mortadza SAS, Alitheen NB. Kefir and Its Biological Activities. Foods. 2021; 10: 1210.

[31] Triwibowo B, Wicaksono R, Antika Y, Ermi S, Jarmiati A, Setiadi AA, Syahriar R. The Effect of Kefir Grain Concentration and Fermentation Duration on Characteristics of Cow Milk-Based Kefir. J. Phys. Conf. Ser. 2020; 1444, 012001.

[32] Al-Mohammadi AR, Ibrahim RA, Moustafa AH, Ismaiel AA, Abou Zeid A, Enan G. Chemical Constitution and Antimicrobial Activity of Kefir Fermented Beverage. Molecules. 2021; 26: 2635.

[33] Bensmira M, Nsabimana C, Jiang B. Effects of fermentation conditions and homogenization pressure on the rheological properties of Kefir. Food Sci. Technol. 2010; 43; 1180–1184.

[34] Bolla PA, Carasi P, Bolla Mde L, De Antoni GL, Serradell Mde L. Protective effect of a mixture of kefir-isolated lactic acid bacteria and yeasts in a hamster model of Clostridium difficile infection. Anaerobe. 2013; 21: 28–33.

[35] Chen HC, Wang SY, Chen MJ. Microbiological study of lactic acid bacteria in kefir grains by culture-dependent and culture-independent methods. Food Microbiol. 2008; 25:492–501.

[36] Diosma G, Romanin DE, Rey-Burusco MF, Londero A, Garrote GL. Yeasts from kefir grains: Isolation, identification, and probiotic characterization. World J. Microbiol. Biotechnol. 2014; 30: 43–53.

[37] Chen Z, Shi J, Yang X, Nan B, Liu Y, Wang Z. Chemical and physical characteristics and antioxidant activities of the exopolysaccharide produced by Tibetan kefir grains during milk fermentation. Int. Dairy J. 2015; 43: 15–21.

[38] Garofalo C, Osimani A, Milanovic V, Aquilanti L, De Filippis F, Stellato G, ˇ et al. Bacteria and yeast microbiota in milk kefir grains from different Italian regions. Food Microbiol. 2015; 49: 123–133.

[39] Garrote GL, Abraham AG, De Antoni GL. Chemical and microbiological characterisation of kefir grains. J. Dairy Res. 2001; 68: 639–652.

[40] Garrote GL, Abraham AG, De Antoni GL. "Microbial Interactions in Kefir: a Natural Probiotic Drink," in Biotechnology of Lactic Acid Bacteria, eds F. Mozzi, R. R. Raya, and G. M. Vignolo (Ames, IO: Wiley-Blackwell). 2010; 327–340.

[41] Hamet MF, Londero A, Medrano M, Vercammen E, Van Hoorde K, Garrote G L., et al. Application of culture-dependent and cultureindependent methods for the identification of *Lactobacillus kefiranofaciens* in microbial consortia present in kefir grains. Food Microbiol. 2013; 36: 327–334.

[42] Hong WS, Chen HC, Chen YP, Chen MJ. Effects of kefir supernatant and lactic acid bacteria isolated from kefir grain on cytokine production by macrophage. Int. Dairy J. 2009; 19: 244–251.

[43] Huseini HF, Rahimzadeh G, Fazeli MR, Mehrazma M, Salehi M. Evaluation of wound healing activities of kefir products. Burns. 2012; 38: 719–723.

[44] Ismaiel AA, Ghaly MF, El-Naggar AK. Milk kefir: Ultrastructure, antimicrobial activity and efficacy on aflatoxin b1 production by Aspergillus flavus. Curr. Microbiol. 2011; 62: 1602–1609.

[45] Khoury N, El-Hayek S, Tarras O, El-Sabban M, El-Sibai M, Rizk S. Kefir exhibits anti-proliferative and pro-apoptotic effects on colon adenocarcinoma cells with no significant effects on cell migration and invasion. Int. J. Oncol. 2014; 45: 2117–2127.

[46] Farnworth ER. Kefir – A complex probiotic. Food Sci. Technol. Bull. Funct. Foods. 2005; 2: 1–17.

[47] Fontán MCG, Martínez S, Franco I, Carballo J. Microbiological and chemical changes during the manufacture of Kefir made from cows' milk, using a commercial starter culture. Int. Dairy J. 2006; 16: 762–767.

[48] Farnworth ER, Mainville I. "Kefir: a fermented milk product," in Handbook of Fermented Functional Foods, ed. E. R. Farnworth (Boca Raton, FL: CRC Press). 2003; 77–112.

[49] Chen YP, Hsiao PJ, Hong WS, Dai TY, Chen MJ. *Lactobacillus kefiranofaciens* M1 isolated from milk kefir grains ameliorates experimental colitis *in vitro* and *in vivo*. J. Dairy Sci. 2012; 95: 63–74. doi: 10.3168/jds.2011-4696.

[50] Cheirsilp B, Shimizu H, Shioya S. Enhanced kefiran production by mixed culture of *Lactobacillus kefiranofaciens* and *Saccharomyces cerevisiae*. J. Biotechnol. 2003; 100: 43–53.

[51] Cheirsilp B, Radchabut S. Use of whey lactose from dairy industry for economical kefiran production by Lactobacillus kefiranofaciens in mixed cultures with yeasts. N. Biotechnol. 2011; 28: 574–580.

[52] Cevikbas A, Yemni E, Ezzedenn FW, Yardimici T, Cevikbas U, Stohs SJ. Antitumoural, antibacterial and antifungal activities of kefir and kefir grain. Phytother. Res. 1994; 8: 78–82.

[53] Kwon CS, Park MY, Cho JS, Choi ST, Chang DS. Identification of effective microorganisms from kefir fermented milk. Food Sci. Biotechnol. 2003; 12: 476–479.

[54] Oliveira AML, Miguel MAL, Peixoto RS, Rosado AS, Silva JT, Paschoalin VMF. Microbiological, technological and therapeutic properties of kefir: a natural probiotic beverage. Braz. J. Microbiol. 2013; 44: 341–349.

[55] Serafini F, Turroni P, Ruas-Madiedo GA, Lugli C, Milani S, Duranti N. et al. Kefir fermented milk and kefiran promote growth of *Bifidobacterium bifidum* PRL2010 and modulate its gene expression. Int. J. Food Microbiol. 2014; 178: 50–59.

[56] Zheng Y, Lu Y, Wang J, Yang L, Pan C, Huang Y. Probiotic properties of *Lactobacillus* strains isolated from Tibetan Kefir grains. PLoS ONE. 2013; 8:e69868.

[57] Wei-Sheng H, Yen-Po C, Ming-Ju C. The atiallergic effect of kefir *Lactobacilli*. J. Food Sci. 2010; 75: 244–253.

[58] Wang SY, Chen KN, Lo YM, Chiang ML, Chen HC, Liu JR., et al. Investigation of microorganisms involved in biosynthesis of the kefir grain. Food Microbiol. 2012; 32:274–285.

[59] Vujicic IF, Vulic M, Könyves T. Assimilation of cholesterol in milk ´ by kefir cultures. Biotechnol. Lett. 1992; 14: 847–850.

[60] Simova E, Beshkova D, Angelov A, Hristozova T, Frengova G, Spasov Z. Lactic acid bacteria and yeasts in kefir grains and kefir made from them. J. Ind. Microbiol. Biotechnol. 2002; 28: 1–6.

[61] Liu JR, Wang SY, Lin YY, Lin CW. Antitumor activity of milk, kefir and soya milk kefir in tumor bearing mice. Nutr. Cancer. 2002; 44: 183–187.

[62] Raja A, Gajalakshmi P, Raja M. MM, Imran MM. Effect of *Lactobacillus laceiscremoris* isolated from Kefir against food spoilage bacteria. Am. J. Food Technol. 2009; 4: 201–209.

[63] Pogacic T, Sinko S, Zamberlin S, Samarzija D. Microbiota of kefir ´ grains. Mljekarstvo. 2013; 63: 3–14.

[64] Londero A, Hamet MF, De Antoni GL, Garrote GL, Abraham AG. Kefir grains as a starter for whey fermentation at different temperatures: chemical and microbiological characterization. J. Dairy Res. 2012; 79: 262–271.

[65] Botelho PS, Maciel MI, Bueno LA, Marques Mde F, Marques DN, Sarmento Silva TM. Characterization of a new exopolysaccharide obtained from of fermented kefir grains in soymilk. Carbohydr. Polym. 2014; 107: 1–6.

[66] Kooiman P. The chemical structure of kefiran, the water-soluble polysaccharide of the kefir grain. Carbohydr. Res. 1968;7: 220–221.

[67] Azhar MA, Munaim MSA, Isolation and Molecular Identification of Potential Probiotic Yeast Strains Found in Malaysian Kefir Drinks Samples. International Journal of Pharma Medicine and Biological Sciences. 2019; 8: 4.

[68] Jayashree KB, Chalannavar RK, Nandini N, Malabadi RB, Kolkar KP, Divarkar MS. Yeast probiotics fermented food products: Gut microbiome and Women health. World Journal of Advanced Research and Reviews. 2025; 27(01):1209-1230.

[69] Kolkar KP, Malabadi RB, Chalannavar RK, Divakar MS, Moramazi S. Probiotic hemp milk-market growth: An updated review. World Journal of Biology, Pharmacy and Health Sciences. 2025; 23(02): 133-143.

[70] Kolkar KP, Annapurna S, Malabadi RB, Jayashree BK, Chalannavar RK, Divakar MS, Karamchand KS, Baijnath H. Indian probiotic food: Gut health management: An pdated review. World Journal of Biology, Pharmacy and Health Sciences. 2025; 23(01): 431-447.

[71] Chalannavar RK, Malabadi RB, Kolkar KP, Divarkar MS, Swathi, Karamchand KS, Nandini N, Munhoz ANR. Probiotics: Health benefits-An update. World Journal of Advanced Engineering Technology and Sciences. 2025; 15(03): 2395-2403.

[72] Chalannavar RK, Malabadi RB, Kolkar KP, Divarkar MS, Swathi, Karamchand KS, Nandini N, Munhoz ANR. Probiotic Yeasts-An Updated Review. Magna Scientia Advanced Biology and Pharmacy. 2025; 15(01): 49-59.

[73] Kolkar KP, Malabadi RB, Chalannavar RK. Industrial *Cannabis sativa* (Hemp) seeds used as Probiotic Energy Milk Drink-An Update. GSC Advanced Research and Reviews. 2025; 25(01): 074-086.

[74] Peluzio MDCG, Dias MME, Martinez JA, Milagro FI. Kefir and intestinal microbiota modulation: Implications in human health. Front Nutr. 2021;8:638740.

[75] Noğay NH. Kefir beverage and its effects on health. In: Milk‐based beverages. 2019;9: 273–296.

[76] Samie AH. The fascinating origins of milk kefir grains. 2023. https://www. britannica. com/topic/kefir.

[77] Hari HS. KefirWala: Kefir grains and kefir drinks. https://www.kefirwala.in/ what‐are‐kefir‐grains/.

[78] **Tingirikari JMR**. Microbiota‐accessible pectic polyoligosaccharides in gut health. Food Funct. 2018;9(10):5059–73.

[79] Tingirikari JMR. *In-vitro* prebiotic analysis of microbiota accessible pectic polysaccharides. Curr Microbiol. 2019;76(12):1452–60.

[80] Kairey L, Leech B, El‐Assaad F, Bugarcic A, Dawson D, Lauche R. The effects of kefir consumption on human health: a systematic review of randomized controlled trials. Nutr Rev. 2023;81(3):267–86.

[81] Rosa DD, Dias MMS, Grześkowiak ŁM, Reis SA, Conceição LL, Peluzio Mdo CG. Milk kefir: nutritional, microbiological and health benefits. Nutr Res Rev. 2017;30(1):82–96.

[82] Kesenkaş H, Gürsoy O, Özbaş H. Chapter 14: Kefir. In: Fermented foods in health and disease prevention. 2017; 339–61.

[83] Guzel‐Seydim ZB, Gökırmaklı Ç, Greene AK. A comparison of milk kefir and water kefir: Physical, chemical, microbiological and functional properties. Trends Food Sci Technol. 2021;113:42–53.

[84] Ganatsios V, Nigam P, Plessas S, Terpou A. Kefir as a functional beverage gaining momentum towards its health promoting attributes. Beverages. 2021;7(3):48.

[85] Egea MB, Santos DC, Filho JGO, Ores JC, Takeuchi KP, Lemes AC. A review of non‐dairy kefir products: Their characteristics and potential human health benefits. Crit Rev Food Sci Nutr. 2022;62(6):1536–52.

[86] Guzel‐Seydim ZB, Şatır G, Gökırmaklı Ç. Use of mandarin and persimmon fruits in water kefir fermentation. Food Sci Nutr. 2023;11:5890–7.

[87] Tzavaras D, Papadelli M, Ntaikou I. From milk kefir to water kefir: Assessment of fermentation processes, microbial changes and evaluation of the produced beverages. Fermentation. 2022;8(3):135.

[88] Gökırmaklı Ç, Güzel‐Seydim ZB. Water kefir grains vs. milk kefir grains: Physical, microbial and chemical comparison. J Appl Microbiol. 2022;132(6):4349–58.

[89] Bourrie BCT, Willing BP, Cotter PD. The microbiota and health promoting characteristics of the fermented beverage kefir. Front Microbiol. 2016;7:647.

[90] Machado de Oliveira Leite A, Miguel MAL, Peixoto RS, Rosado AS, Silva JT, Paschoalin VMF. Microbiological, technological and therapeutic properties of kefir: A natural probiotic beverage. Braz J. Microbiol. 2013;44(2):341–9.

[91] Prado MR, Blandón LM, Vandenberghe LPS, Rodrigues C, Castro GR, Thomaz‐Soccol V, Soccol CR. Milk kefir: composition, microbial cultures, biological activities, and related products. Front Microbiol. 2015;6:1–10.

[92] Martínez‐Torres A, Gutiérrez‐Ambrocio S, Heredia‐del‐Orbe P, Villa‐Tanaca L, Hernández‐Rodríguez C. Inferring the role of microorganisms in water kefir fermentations. Inst Food Sci Technol. 2016;52(2):559–7.

[93] Laureys D, Vuyst L. The water kefir grain inoculum determines the characteristics of the resulting water kefir fermentation process. J. Appl Microbiol. 2017;122(3):719–32.

[94] Moretti AF, Moure MC, Quiñoy F, Esposito F, Simonelli N, Medrano M, León‐Peláez A. Water kefir, a fermented beverage containing probiotic microorganisms: From ancient and artisanal manufacture to industrialized and regulated commercialization. Fut Foods. 2022;5:100123.

[95] Pendón MD, Bengoa AA, Iraporda C, Medrano M, Garrote GL, Abraham AG. Water kefir: Factors affecting grain growth and health‐promoting properties of the fermented beverage. J. Appl Microbiol. 2022;133(1):162–80.

[96] Davidovic ZS, Miljkovic GM, Antonovic GD, Rajilic‐Stojanovic DM, Dimitrijevic‐Brankovic IS. Water kefir grain as a source of potent dextran producing lactic acid bacteria. Hem Ind. 2015;69(6):595–604.

[97] Destro TM, Prates DD, Watanabe LS, Garcia S, Biz G, Spinosa WA. Organic brown sugar and jaboticaba pulp influence on water kefir fermentation. Ciênc Agrotecnol. 2019;9:43.

[98] Corona O, Randazzo W, Miceli A, Guarcello R, Francesca N, Erten H, Moschetti G, Settanni L. Characterization of kefir‐like beverages produced from vegetable juices. LWT Food Sci Technol. 2016;66:572–81.

[99] Leite AMO, Miguel MAL, Peixoto RS, Rosado AS, Silva JT, Paschoalin VMF. Microbiological, technological and therapeutic properties of kefir: a natu ral probiotic beverage. Braz J. Microbiol. 2013;44:341–9.

[100] Syrokou MK, Papadelli M, Ntaikou I, Paramithiotis S, Drosinos EH. Sugary kefir: microbial identification and biotechnological properties. Beverages. 2019;5(4):61.

[101] Blasche S, Kim Y, Mars RA, Machado D, Maansson M, Kafkia E, Milanese A, et al. Metabolic cooperation and spatiotemporal niche partitioning in a kefir microbial community. Nat Microbiol. 2021;6(2):196–208.

[102] Nejati F, Junne S, Neubauer P. A big world in small grain: A review of natural milk kefir starters. Microorganisms. 2020;8(2):192.

[103] Basaran O, Telci E. A study on kefir, a popular drink. J Basic Health. 2022;1(1):20–38.

[104] Rattray FP, O'Connell MJ. Fermented milks: Kefir. In: Encyclopaedia of dairy sciences, 2nd ed. San Diego: Academic Press; 2011; 518–524.

[105] Satir G, Guzel‐Seydim ZB. The effect of kefir fermentation on the protein profile and the monoterpenic bioactive compounds in goat milk. Int Dairy J. 2023;137:105532.

[106] Fiorda FA, Melo Pereira GV, Thomaz‐Soccol V, Rakshit SK, Pagnoncelli MGB, Vandenberghe LPS, Soccol CR. Microbiological, biochemical, and functional aspects of sugary kefir fermentation: A review. Food Microbiol. 2017;66:86–95.

[107] Kahraman M, Ertekin YH, Satman I. The effects of kefir on kidney tissues and functions in diabetic rats. Probiotics Antimicrob Proteins. 2021;13:375–82.

[108] Lima MDSF, Silva RA, Silva MF, Silva PAB, Costa RMPB, Teixeira JAC, Porto ALF, Cavalcanti MTH. Brazilian kefir‐fermented sheep's milk, a source of antimicrobial and antioxidant peptides. Probiotics Antimicrob Proteins. 2018;10(3):446–55.

[109] Vieira LV, Macedo de Sousa L, Maia TAC, Gusmão JNFM, Goes P, Pereira KMA, Miyajima F, Gondim DV. Milk kefir therapy reduces inflammation and alveolar bone loss on periodontitis in rats. Biomed Pharmacother. 2021;139:111677.

[110] Kim DH, Jeong CH, Cheng WN, Kwon HC, Kim DH, Seo KH, Choi Y, Han SG. Effects of kefir on doxorubicin‐induced multidrug resistance in human colorectal cancer cells. J. Funct Foods. 2021;78:104371.

[111] Fatahi A, Soleimani N, Afrough P. Anticancer activity of kefir on glioblastoma cancer cell as a new treatment. Int J Food Sci. 2021;8180742:5.

[112] Maalouf K, Baydoun E, Rizk S. Kefir induces cell‐cycle arrest and apoptosis in HTLV‐1‐negative malignant T‐lymphocytes. Cancer Manag Res. 2011;14:39–47.

[113] Rosa DD, Dias MMS, Grześkowiak LM, Reis SA, Conceição LL, Peluzio MDCG. Milk kefir: nutritional, microbiological and health benefits. Nutri Res Rev. 2017;30(1):82–96.

[114] Al‐Mohammadi AR, Ibrahim RA, Moustafa AH, Ismaiel AA, Abou Zeid A, Enan G. Chemical constitution and antimicrobial activity of kefir fermented beverage. Molecules. 2021;26(9):2635.

[115] Shen Y, Kim DH, Chon JW, Kim H, Song KY, Seo KH. Nutritional effects and antimicrobial activity of Kefir (Grains). J Milk Sci Biotechnol. 2018;36:1–13.

[116] Tun‐Aytekin O, Seker A, Arısoy S. The effect of in vitro gastrointestinal simulation on bioactivities of kefir. Int J Food Sci Technol. 2019;55(1):283– 92.

[117] Demir H. Comparison of traditional and commercial kefir microorganism compositions and inhibitory effects on certain pathogens. Int J. Food Prop. 2020;23(1):375–86.

[118] Gut AM, Vasiljevic T, Yeager T, Donkor ON. Antimicrobial properties of traditional kefir: An *in vitro* screening for antagonistic effect on *Salmonella typhimurium* and *Salmonella arizonae*. Int Dairy J. 2022;124: 105180.

[119] Marques VD, Franzolin MR, Sanabani SS, Vigerelli H, Piazza RMF, Pimenta DC, et al. A new class of antimicrobial molecules derived from kefir, effective against *Pseudomonas aeruginosa* and methicillin resistant *Staphylo- coccus aureus* (MRSA) strains. Sci Rep. 2020;10:17434.

[120] Pereira MFA, Albuini FM, Peluzio MCG. Anti‐inflammatory pathways of kefir in murine model: a systematic review. Nutr Rev. 2024;82(2):210–27.

[121] Ye Z, Yang X, Deng B, Liao Z, Fang X, Wang J. Prevention of DSS‐induced colitis in mice with water kefir microbiota via anti‐inflammatory and microbiota‐balancing activity. Food Funct. 2023;14:6813–27.

[122] Lai YW, Ko CH, Chen HL, Chen CM. Anti‐Inflammatory effect and bone protection of kefir peptides in a rat model of adjuvant‐induced rheumatoid arthritis. FASEB J. 2019;33(1):lb133.

[123] Ekici O, Aslan E, Aladag T, Guzel H, Koekmaz OA, Bostanci A, Sadi G, Pektas MB. Masseter muscle and gingival tissue inflammatory response following treatment with high‐fructose corn syrup in rats: anti‐inflammatory and antioxidant effects of kefir. J Food Biochem. 2021;46(3):e13732.

[124] Pimenta FS, Regueira ML, Ton AMM, Campagnaro BP, Toimil MC, Pereiraa TMC, Vasquez EC. Mechanisms of action of kefir in chronic cardiovascular and metabolic diseases. Cell Physiol Biochem. 2018;48(5):1901–14.

[125] Hadisaputro S, Djokomoeljanto RRJ, Soesatyo MHNE. The effects of oral plain kefir supplementation on proinflammatory cytokine properties of the hyperglycemia wistar rats induced by streptozotocin. Acta Med Indones. 2012;44(2):100–4.

[126] Liao CH, Yen CC, Chen HL, Liu YH, Chen YH, Lan YW, Chen KR, Chen W, Chen CM. Novel kefir exopolysaccharides (KEPS) mitigate lipopolysaccha‐ ride (LPS)‐induced systemic inflammation in luciferase transgenic mice through inhibition of the NF‐κB pathway. Antioxidants. 2023;12(9):1724.

[127] Nascimento da Silva K, Favero AG, Ribeiro W, Ferreira CM, Sartorelli P, Cardili L, et al. Effects of kefir fermented milk beverage on sodium dextran sulfate (DSS)‐induced colitis in rats. Heliyon. 2023;2023(9):e12707.

[128] Chuang KC, Lai YW, Ko CH, Yen CC, Chen HL, Lan YW, et al. Therapeutic effects of kefir peptides on adjuvant‐induced arthritis in rats through anti‐inflammation and downregulation of matrix metalloproteinases. Life Sci. 2023;317:121411.

[129] Rajoka MSR, Mehwish HM, Fang H, Padhiar AA, Zeng X, Khurshid M, He Z, Zhao L. Characterization and anti‐tumor activity of exopolysaccharide produced by Lactobacillus kefiri isolated from Chinese kefir grains. J. Funct Foods. 2019;63:103588.

[130] Cai Y, Sounderrajan A, Serventi L. Water kefir: A review of its microbiological profile, antioxidant potential and sensory quality. Acta Sci Nutr Health. 2020;6:10–7.

[131] Łopusiewicz Ł, Drozłowska E, Trocer P, Kwiatkowski P, Bartkowiak A, Gefrom A, Sienkiewicz M. The effect of fermentation with kefir grains on the physicochemical and antioxidant properties of beverages from blue lupin (Lupinus angustifolius L.) Seeds. Molecules. 2020;25(24):5791.

[132] Ilıkkan OK, Bağdat ES. The efect of kefr enrichment with *Arthrospira platensis* and *Chlorella vulgaris* on kefr microbiota, antioxidant, and physicochemical properties. J. Appl Phycol. 2023;35:713–20.

[133] Laela N, Legowo AM, Fulyani F. The effect of kefir‐spirulina on glycemic status and antioxidant activity in hyperglycemia rats. Slovak J Food Sci. 2021;15:101–10.

[134] Erdogan FS, Ozarslan S, Guzel‐Seydim ZB, Taş TT. The effect of kefir produced from natural kefir grains on the intestinal microbial populations and antioxidant capacities of Balb/c mice. Food Res Int. 2019;115:408–13.

[135] Ghoneum M, Abdulmalek S, Pan D. Reversal of age‐associated oxidative stress in mice by PFT, a novel kefir product. Int J. Immunopathol Pharmacol. 2020;34:1–17.

[136] Salari A, Hashemi M, Afshari A. Functional Properties of Kefiran in the Medical Field and Food Industry. Curr Pharm Biotechnol. 2022; 23(3):388-395.

[137] Georgalaki M, Zoumpopoulou G, Anastasiou R, Kazou, M, Tsakalidou E. Lactobacillus kefiranofaciens: From Isolation and Taxonomy to Probiotic Properties and Applications. Microorganisms. 2021; 9: 2158.

[138] Azizi NF, Kumar MR, Yeap SK, Abdullah JO, Khalid M, Omar AR, Osman MA, Mortadza SAS, Alitheen NB. Kefir and Its Biological Activities. Foods. 2021 27;10(6):1210.

[139] Ströher JA, Oliveira WdC, Freitas ASd, Salazar MM, Flôres SH, Malheiros PdS. Microbial Dynamics and Volatile Compound Profiles in Artisanal Kefir During Storage. Fermentation. **2025**; 11:105. https://doi.org/10.3390/fermentation11020105.

[140] Mukai T, Toba T, Itoh T, Adachi S. Structural investigation of the capsular polysaccharide from Lactobacillus kefranofaciens K1. Carbohydr. Res. 1990; 204: 227–232.

[141] Salari A, Hashemi M, Afshari A. Functional Properties of Kefiran in the Medical Field and Food Industry. Curr Pharm Biotechnol. 2022;23(3):388-395.

[142] La Riviére JWM, Kooiman P, Schmidt K. Kefiran, A novel polysaccharide produced in the kefir grain by *Lactobacillus brevis* . *Archiv. Mikrobiol.* 1967; **59**: 269–278.

[143] Bozkir E, Yilmaz B, Sharma H, Esatbeyoglu T, Ozogul F. Challenges in water kefir production and limitations in human consumption: A comprehensive review of current knowledge. Heliyon. 2024; 22;10(13):e33501.

[144] Cheirsilp B, Suksawang S, Yeesang J, Boonsawang P. Co-production of functional exopolysaccharides and lactic acid by *Lactobacillus kefiranofaciens* originated from fermented milk, kefir. J Food Sci Technol. 2018;55(1):331-340.

[145] **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.

[146] 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

[147] 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.

[148] Aroua M, Ben Haj Koubaier H, Bouacida S, Ben Saïd S, Mahouachi M, Salimei E. Chemical, Physicochemical, Microbiologi_cal, Bioactive, and Sensory Characteristics of Cow and Donkey Milk Kefir during Storage. Beverages. 2023; 9: 2.

[149] Yilmaz-Ersan L, Ozcan T, Akpinar-Bayizit A, Sahin S. Comparison of Antioxidant Capacity of Cow and Ewe Milk Kefirs. J. Dairy Sci. 2018; 101: 3788–3798.

[150] Gentry B, Cazón P, O'Brien K. A Comprehensive Review of the Production, Beneficial Properties, and Applications of Kefiran, the Kefir Grain Exopolysaccharide. Int. Dairy J. 2023; 144: 105691.