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Namrata G Khirodkar
S.V.G.I College of Agriculture, Jalgaon-Jamod, Buldhana, Maharashtra, India

Sandeep Sankpal
Vasantdada Sugar Institute, Manjari (Bk), Haveli, Pune, Maharashtra, India

Pappu S Mujmule
Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Sanjay
Department of Livestock Production and Management, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Corresponding Author:
Namrata G Khirodkar
S.V.G.I College of Agriculture, Jalgaon-Jamod, Buldhana, Maharashtra, India

Nutritional and functional properties of fermented dairy products: Current scientific evidence, health benefits and future perspectives

Namrata G Khirodkar, Sandeep Sankpal, Pappu S Mujmule and Sanjay

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Abstract
Fermented dairy products are widely recognized as nutrient-rich foods that combine the nutritional benefits of milk with the functional properties generated through microbial fermentation. During fermentation, lactic acid bacteria and other microorganisms transform milk components through acidification, proteolysis, lactose metabolism and the production of bioactive compounds, resulting in products with improved digestibility, sensory characteristics, shelf life, and potential health-promoting effects. This review provides a comprehensive overview of major fermented dairy products, including yogurt, kefir, *dahi*, cultured milk, and related products, with emphasis on microbial diversity, fermentation-derived bioactive components, gut microbiota modulation, and human health implications. Current evidence strongly supports the role of fermented dairy products in improving lactose digestion and gastrointestinal health, while emerging research indicates potential benefits for gut microbiota composition, immune regulation, cardiometabolic health, bone health and inflammatory responses. Advances in probiotic fortification, postbiotic incorporation, synbiotic formulations, precision fermentation and microbiome-oriented product development have further expanded the scientific and commercial relevance of fermented dairy foods. However, variability in microbial composition, processing conditions, product standardization and study methodologies continues to limit the consistency and translation of research findings. In addition, many proposed health benefits require further validation through well-designed long-term clinical studies. Future research should focus on standardized product characterization, multi-omics approaches, precision nutrition strategies, and robust human intervention trials to better understand the mechanisms underlying the health effects of fermented dairy products. Overall, fermented dairy products represent a rapidly evolving area of food and nutrition science with considerable potential to contribute to human health, functional food innovation, and sustainable dietary systems.

Keywords: Fermented dairy products, yogurt, kefir, probiotics, postbiotics, gut microbiota, bioactive peptides, functional foods, human health

1. Introduction

Fermented dairy products are among the oldest examples of purposeful food biotransformation and continue to play a major role in human diets because fermentation improves preservation, palatability, and product diversity while retaining the core nutrient richness of milk (Nagpal, 2012; Saleem *et al*., 2024, Kaur, 2022) [22, 31, 17]. In modern food science, their importance has expanded further because fermented dairy foods are now evaluated not only as sources of high-quality protein, calcium, phosphorus, potassium and vitamins, but also as dynamic food matrices shaped by microbial metabolism and process-dependent biochemical change (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33].

This distinction is important. Fermentation does not simply store milk in another form; it modifies the substrate through lactose utilization, acidification, proteolysis, and formation of metabolites that may alter digestibility and physiological response (Nagpal, 2012; Saleem *et al*., 2024) [22, 31]. As a result, fermented dairy products such as yogurt, cultured fermented milk, kefir, cheese, and related beverages are increasingly discussed within the framework of functional foods, particularly in relation to gastrointestinal health, probiotic delivery, immunomodulation, and metabolic outcomes (Shiby, 2013; Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [36, 31, 33].

Among these products, yogurt and cultured fermented milk currently have the strongest human evidence base. In a qualitative systematic review conducted using PRISMA-guided methods, Savaiano and Hutkins (2021) [33] screened 1,057 abstracts and included 108 studies, concluding that the clearest causal evidence concerns lactose digestion and tolerance, while consistent associations also exist for reduced risk of type 2 diabetes, improved weight maintenance, and favorable gastrointestinal, cardiovascular, and bone-related outcomes. However, the same review also shows that the literature is not uniformly conclusive: many studies were neutral, some were methodologically limited, and benefits were not identical across all fermented dairy categories.

This heterogeneity is one of the central scientific challenges in the field. The term "fermented dairy products" encompasses foods with very different microbiological ecologies, processing technologies, textures, nutrient concentrations, and consumption patterns. Yogurt made with the classical thermophilic starter pair differs fundamentally from kefir produced with mixed bacterial-yeast cultures, and both differ from ripened cheese in terms of fermentation kinetics, metabolite formation, and likely mechanisms of action (Saleem *et al*., 2024; Pang *et al*., 2025) [31, 25]. Consequently, broad claims about fermented dairy as a single category may obscure important differences between products, strains, and target populations (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33].

The current rise of microbiome science has further intensified interest in fermented dairy. Products containing live microorganisms or fermentation-derived metabolites are now being investigated as modulators of gut ecology and host response, yet enthusiasm has sometimes outpaced evidentiary precision. Mechanistic plausibility is strong for several pathways, including lactose hydrolysis, microbial metabolite exposure, and peptide generation, but translational certainty is much lower for some widely cited claims related to inflammation, cancer prevention, and systemic disease modification (Saleem *et al*., 2024; Savaiano & Hutkins, 2021; Pang *et al*., 2025) [31, 33, 25]. This makes critical synthesis essential.

The public health relevance of this topic is also substantial. Fermented dairy products combine nutrient density with broad cultural acceptance, are available in both traditional and industrial forms, and may provide options for individuals who tolerate fermented dairy better than unfermented milk (Savaiano & Hutkins, 2021) [33]. At the same time, dietary guidelines and policy discussions have generally emphasized dairy in aggregate rather than distinguishing between fermented and non-fermented dairy matrices, even though the evidence suggests that these foods may not be physiologically equivalent in all contexts (Savaiano & Hutkins, 2021) [33].

Against this background, the present review aims to critically analyze the nutritional and functional properties of fermented dairy products, evaluate the strength and limitations of current health evidence, and identify the major scientific and translational questions that should guide future research. Particular emphasis is placed on publication-quality synthesis, methodological transparency, and careful separation of well-supported conclusions from hypotheses that remain promising but insufficiently confirmed (Page *et al*., 2021; Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [24, 31, 33].

2. Review Methodology

2.1 Literature Search Strategy

This review was designed using a PRISMA-inspired evidence-synthesis framework aligned with the PRISMA 2020 Statement, which updated reporting guidance for systematic reviews and revised expectations for transparency in study identification, selection, appraisal, and reporting (Page *et al*., 2021) [24]. Because the present article is a broad scholarly review rather than a formal meta-analysis, PRISMA was applied as a methodological structure for transparent literature mapping rather than as a strict quantitative synthesis template (Page *et al*., 2021) [24].

The search strategy was constructed around the major concept domains specified in the review question: fermented dairy products, yogurt, cultured fermented milk, kefir, dahi, cheese, cultured buttermilk, probiotics, functional foods, lactic acid bacteria, dairy microbiology, bioactive peptides, and gut health. These terms were used singly and in Boolean combinations across PubMed, Scopus, Web of Science, ScienceDirect, SpringerLink, Wiley Online Library, and Google Scholar, with primary emphasis on studies published from 2010 onward and prioritization of literature from 2020 to 2026 for final synthesis where possible (Page *et al*., 2021; Savaiano & Hutkins, 2021) [24, 33]. Landmark earlier works were considered eligible only when necessary to establish definitions, foundational mechanisms, or historically important evidence streams that remain central to interpretation (Savaiano & Hutkins, 2021) [33].

Search sensitivity was favored over excessive restriction during the initial stage because fermented dairy research is dispersed across dairy science, food chemistry, microbiology, nutrition, and clinical journals. However, during screening, preference was given to peer-reviewed journal articles with clear product characterization and explicit relevance to nutritional, microbiological, functional, or health-related endpoints (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33].

2.2 Inclusion and Exclusion Criteria

Studies were eligible for inclusion if they m*et al*l of the following criteria:

- Published in peer-reviewed journals.
- Focused on fermented dairy products or clearly defined fermented milk matrices.
- Addressed at least one relevant domain, including nutritional composition, fermentation microbiology, bioactive compounds, functional properties, gut health, metabolic health, or broader human health implications.
- Provided sufficient methodological detail to determine the nature of the product, study design, and outcomes assessed (Shiby, 2013; Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [36, 31, 33].

Priority was assigned to systematic reviews, authoritative narrative reviews, randomized controlled trials, prospective cohort studies, and landmark mechanistic investigations that directly informed interpretation of product functionality or health relevance (Savaiano & Hutkins, 2021) [33]. PRISMA 2020 guidance was used to support transparent documentation of selection logic and synthesis rationale (Page *et al*., 2021) [24].

The following were excluded

- Non-peer-reviewed publications, editorials without substantive synthesis, conference abstracts lacking full data, and non-verifiable reports.

- Studies on fermented non-dairy foods unless directly relevant as mechanistic comparators.
- Articles in which the dairy product was insufficiently characterized or where fermentation status was unclear.
- Publications making broad health claims without traceable primary evidence or adequate methodological description (Page *et al*., 2021) [24].

These criteria were intentionally strict because the topic is vulnerable to overgeneralization. Fermented dairy products vary greatly in microbial ecology, processing history, and nutrient profile, so studies with poor product definition contribute disproportionately to interpretive noise (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33].

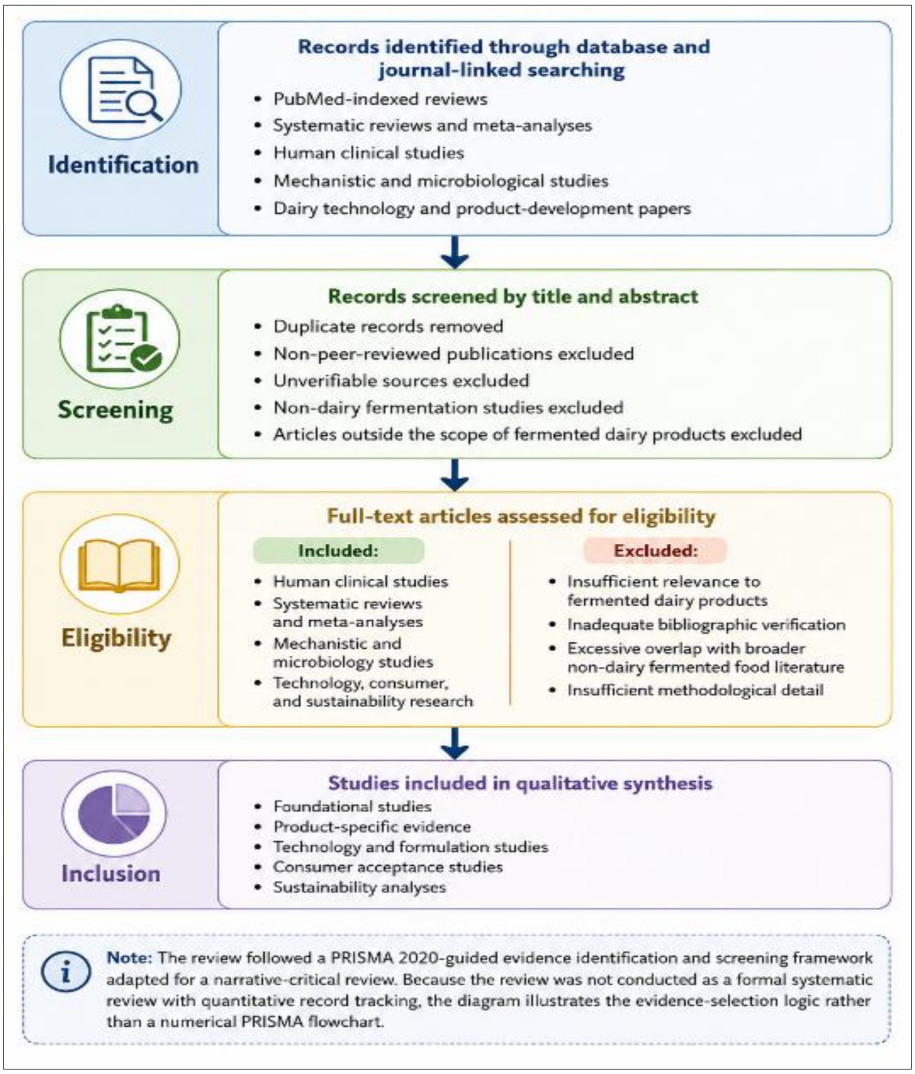

Fig 1: PRISMA-Guided Literature Identification and Selection Process

2.3 Data Extraction Process

Data extraction was organized around five analytical domains:

1. Product identity and processing characteristics.
2. Microbiological composition, including starter cultures or probiotic strains where reported.
3. Nutritional or biochemical transformations attributed to fermentation.
4. Functional or health outcomes assessed.
5. Methodological strengths and limitations relevant to interpretation (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33].

For reviews and human studies, particular attention was paid to the definition of the fermented dairy matrix, comparator choice, intervention duration, outcome specificity, and whether conclusions were based on observational associations, controlled interventions, or mechanistic reasoning. This distinction was necessary because the strongest claims in the field often depend on the quality of causal inference rather than on the number of positive studies alone (Savaiano & Hutkins, 2021) [33].

2.4 Quality Assessment

Formal meta-analytic risk-of-bias tools were not applied across all included sources because this review is broader in scope and includes narrative reviews, systematic reviews, and mechanistic literature in addition to primary trials. Instead, quality was assessed narratively using principles consistent with PRISMA 2020 reporting transparency and with the evaluative approach reflected in the systematic review by Savaiano and Hutkins (2021) [33], which differentiated favorable, neutral, and unfavorable findings while also considering study quality.

Greater interpretive weight was assigned to studies and reviews with the following features:

- Transparent search and screening methods.
- Clear identification of fermented dairy product type.

- Explicit microbial or starter culture characterization.
- Appropriate comparators.
- Clinically relevant endpoints.
- Cautious interpretation consistent with study design (Page *et al*., 2021; Savaiano & Hutkins, 2021) [24, 33].

Lower weight was assigned to studies with poorly defined products, inadequate controls, unsupported causal language, or claims extrapolated far beyond the underlying evidence base. This was especially important because recent narrative reviews, while often informative, sometimes aggregate wide-ranging health claims that are stronger in mechanistic plausibility than in direct clinical confirmation (Saleem *et al*., 2024; Pang *et al*., 2025) [31, 25].

2.5 PRISMA Flow Diagram

The review process followed the four broad PRISMA phases of identification, screening, eligibility, and inclusion, as recommended in the PRISMA 2020 update (Page *et al*., 2021) [24].

- **Identification:** Records were sought from PubMed, Scopus, Web of Science, ScienceDirect, SpringerLink, Wiley Online Library, and Google Scholar using predefined keyword combinations related to fermented dairy products, microbiology, nutrition, and health outcomes (Page *et al*., 2021; Savaiano & Hutkins, 2021) [24, 33].
- **Screening:** Duplicates were removed, after which titles and abstracts were screened for direct relevance to fermented dairy products and at least one predefined analytical domain, such as nutritional composition, bioactive compounds, microbial ecology, or health outcomes (Page *et al*., 2021) [24].
- **Eligibility:** Full texts were assessed for peer-review status, adequacy of product definition, methodological transparency, and relevance to the scope of the review. Articles lacking clear fermented dairy characterization, lacking sufficient methodological detail, or making unsupported claims were excluded at this stage (Page *et al*., 2021) [24].
- **Inclusion:** Final inclusion prioritized recent peer-reviewed reviews and landmark primary studies needed to interpret current evidence on nutritional value, fermentation-derived bioactivity, and health effects, with particular weight assigned to systematic reviews and high-quality human evidence where available (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33].

3. Overview of Fermented Dairy Products

Fermented dairy products are obtained through the controlled action of microorganisms on milk or milk-derived substrates, leading to acidification, biochemical remodeling, preservation, and sensory transformation. Contemporary reviews consistently define this category as including yogurt, cultured fermented milk, kefir, cheese, cultured buttermilk, and region-specific products such as dahi and lassi, although the degree of process standardization differs markedly across products and regions (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33]. This definitional breadth is scientifically relevant because "fermented dairy products" are often grouped together in nutrition discourse even though they differ substantially in microbial ecology, texture, nutrient concentration, ripening dynamics, and likely physiological effects (Saleem *et al*., 2024; Widyastuti *et al*., 2021) [31, 38]. Fermented dairy products encompass a diverse range of products that differ in microbial composition, fermentation characteristics, nutritional attributes, and potential health benefits. A comparative overview of major fermented dairy products, their associated microorganisms, fermentation characteristics, key bioactive components, and reported health benefits is presented in Table 1.

Yogurt remains the most standardized fermented milk, traditionally produced by the symbiotic thermophilic starter pair *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*. Its technological identity is relatively well defined compared with many other fermented dairy foods, which partly explains why yogurt dominates the evidence base for lactose digestion and broader health outcomes (Savaiano & Hutkins, 2021; Savaiano, 2014) [33, 32]. By contrast, cultured fermented milks and traditional dahi-type products may vary in inoculum composition, fermentation temperature, solids content, and post-fermentation handling, producing greater heterogeneity in both nutritional profile and biological interpretation (Saleem *et al*., 2024) [31].

Kefir occupies a distinct position because its fermentation often involves mixed bacterial and yeast communities rather than only conventional lactic starters. This mixed ecology generates a broader metabolic spectrum, including carbon dioxide, trace ethanol, organic acids, and exopolysaccharides, and may therefore produce functionality that is not directly comparable to yogurt (Saleem *et al*., 2024; Sibanda *et al*., 2024; Lim *et al*., 2026) [31, 37, 20]. At the same time, kefir research is complicated by product variability: grain-based artisanal kefir, industrial kefir-like beverages, and products made with defined starters are not microbiologically equivalent, yet they are sometimes treated as a single entity in review literature (Lim *et al*., 2026) [20].

Cheese constitutes an even broader class because fermentation is followed, in many varieties, by coagulation, whey drainage, salting, and ripening. As a result, cheeses represent fermented dairy matrices in which concentration effects, moisture loss, ripening microbiota, and proteolytic maturation strongly shape nutritional density and peptide generation, distinguishing them from fresh fermented milks (Saleem *et al*., 2024; Widyastuti *et al*., 2021) [31, 38]. This distinction matters because nutritional comparisons between fermented and non-fermented dairy are more straightforward for yogurt versus milk than for ripened cheese versus fluid milk, where processing-induced concentration effects confound simple interpretation (Saleem *et al*., 2024) [31].

A recurring issue across the literature is overgeneralization of the category. Reviews increasingly present fermented dairy foods as functional foods, but the evidence does not support a uniform effect size or mechanism across all products (Saleem *et al*., 2024; Savaiano & Hutkins, 2021; Arslan *et al*., 2026) [31, 33, 2]. The most defensible interpretation is therefore matrix-specific: fermentation is a unifying process, but the resulting foods differ enough that claims about digestibility, bioactive compound content, microbiome modulation, or health benefit must be interpreted by product type rather than by category label alone (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33].

4. Microbiology of Fermented Dairy Products

The microbiology of fermented dairy products is centered on lactic acid bacteria (LAB), whose primary technological functions include lactose metabolism, acidification, inhibition of undesirable microorganisms, textural development, and flavor generation. Recent reviews continue to identify LAB as the dominant microbial engine of dairy fermentation, with *Streptococcus*, *Lactobacillus* sensu lato, *Lactococcus*, *Leuconostoc*, and *Bifidobacterium* among the most relevant genera in cultured dairy systems (Saleem *et al*., 2024; Widyastuti *et al*., 2021) [31, 38].

In yogurt, the classical association between *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* remains the core model of cooperative dairy fermentation. Their metabolic interaction accelerates acid production and contributes to flavor and texture formation, which is one reason yogurt is technologically robust and comparatively reproducible across industrial settings (Savaiano, 2014; Saleem *et al*., 2024) [32, 31]. However, even within yogurt, product functionality is not determined solely by the classical starter pair. The addition of probiotic adjuncts such as *Lactobacillus acidophilus*, *Lacticaseibacillus casei*, *Lacticaseibacillus rhamnosus*, or bifidobacteria can change viability profiles, enzyme activity, metabolite formation, and possibly health outcomes, though these benefits remain strain-dependent and cannot be inferred from species names alone (Widyastuti *et al*., 2021; Savaiano & Hutkins, 2021) [38, 33].

Kefir microbiology is more complex than yogurt microbiology because kefir grains or kefir-like cultures contain consortia of LAB, yeasts, and sometimes acetic acid bacteria. Reviews of kefir emphasize that these symbiotic communities may include *Lactobacillus kefiranofaciens*, *Lentilactobacillus kefiri*, *Lactococcus lactis*, *Leuconostoc* spp., and various yeasts, with community structure influenced by substrate, geography, and fermentation conditions (Sibanda *et al*., 2024; Lim *et al*., 2026) [37, 20]. This complexity may expand the metabolic repertoire of the final product, but it also introduces a reproducibility challenge absent from more standardized fermented milks. In practice, the term "kefir" often covers products with very different microbial compositions, making cross-study comparison difficult unless microbial communities are explicitly characterized (Lim *et al*., 2026; Saleem *et al*., 2024) [20, 31].

Across fermented dairy products, microbial activity contributes not only to fermentation itself but also to preservation. Acidification lowers pH and suppresses many spoilage and pathogenic organisms, while additional metabolites such as hydrogen peroxide, diacetyl, and bacteriocin-like substances may strengthen inhibitory effects, especially in model systems (Saleem *et al*., 2024; Widyastuti *et al*., 2021) [31, 38]. Yet it is important to distinguish food preservation roles from direct human health claims: evidence for antimicrobial activity in the food matrix or *in vitro* does not automatically establish a clinically meaningful antimicrobial effect after consumption (Lee *et al*., 2026; Saleem *et al*., 2024).

Another key issue is viability. Classical fermentation microbiology assumes that live cultures are important for product identity and some physiological effects, especially in yogurt and probiotic fermented milks. Historical and modern lactose-digestion studies support this position for yogurt because viable or at least enzyme-active cultures contribute β-galactosidase activity in the gastrointestinal tract (Martini *et al*., 1991; Savaiano, 2014; Savaiano & Hutkins, 2021) [21, 32, 33]. However, emerging reviews on postbiotics and fermentation-derived metabolites suggest that live-cell survival may not be the only route to functionality in fermented dairy, particularly for outcomes linked to bioactive peptides or non-viable microbial components (Arslan *et al*., 2026) [2]. This marks an important conceptual transition in the field: microbial viability remains critical for some claims, but not necessarily for all.

Methodologically, dairy microbiology has also evolved. Culture-based enumeration remains useful for quality control, but molecular tools increasingly reveal that fermented dairy ecosystems are more dynamic than traditional counts suggest (Widyastuti *et al*., 2021) [38]. This is especially important for kefir, ripened cheeses, and multifunctional fermented dairy products, where ecological succession and subdominant taxa may influence flavor development and metabolite formation disproportionately relative to their abundance (Lim *et al*., 2026; Widyastuti *et al*., 2021) [20, 38]. Future reviews and primary studies will need better culture-level and strain-level resolution if claims about fermentation-driven functionality are to be mechanistically precise.

5. Nutritional Composition of Fermented Dairy Products

Fermented dairy products retain the nutritional strengths of milk while modifying nutrient digestibility, bioaccessibility, and food structure through microbial activity. They remain important sources of high-quality protein, calcium, phosphorus, potassium, and vitamins, particularly in yogurt and cultured fermented milk (Saleem *et al*., 2024; Savaiano & Hutkins, 2021) [31, 33].

Protein quality is a key advantage because fermentation partially hydrolyzes milk proteins, generating peptides and free amino acids that may enhance digestibility and contribute to flavor development (Choi, 2012; Peres *et al*., 2024; Park *et al*., 2015) [7, 27, 26]. Although fermented dairy products are recognized as sources of bioactive peptides, evidence linking these compounds to specific clinical benefits remains limited (Korhonen, 2009; Choi, 2012; Peres *et al*., 2024) [18, 7, 27].

Lactose metabolism represents one of the most established nutritional benefits of fermentation. Active yogurt cultures provide microbial β-galactosidase, which improves lactose digestion and tolerance beyond the effect of lactose reduction alone (Savaiano, 2014; Martini *et al*., 1991; Savaiano *et al*., 1984) [32, 21, 35]. Studies further indicate that yogurt improves lactose digestion more consistently than some other cultured dairy products, highlighting the importance of product matrix, microbial viability, and enzyme activity (Savaiano *et al*., 1984; Savaiano & Illikoud *et al*., 2022).

Fermented dairy products are also major dietary sources of calcium and phosphorus and may support bone health. Fermentation-derived phosphopeptides have been suggested to enhance mineral utilization, although evidence in humans remains limited (Park *et al*., 2015; Peres *et al*., 2024) [26, 27]. The lipid fraction may also undergo fermentation-induced modifications, but the nutritional significance varies considerably among products such as yogurt, kefir, and cheese (Arslan *et al*., 2026; Saleem *et al*., 2024) [2, 31]. In addition, microbial activity can influence vitamin content, particularly B-group vitamins, although these effects are highly strain- and product-dependent (Saleem *et al*., 2024; Arslan *et al*., 2026) [31, 2]. Overall, fermented dairy products should be viewed as nutritionally modified food systems whose benefits depend on the specific product, microbial composition, and processing conditions.

6. Bioactive Components Generated During Fermentation

The generation of bioactive components during dairy fermentation is one of the strongest mechanistic arguments for considering fermented dairy products as functional foods. Fermentation activates microbial enzymes that hydrolyze proteins, remodel carbohydrates, generate organic acids, synthesize exopolysaccharides, and produce a range of low-molecular-weight metabolites that may influence product functionality and, in some cases, host physiology (Peres *et al*., 2024; Park *et al*., 2015; Arslan *et al*., 2026) [27, 26, 2]. However, the literature also shows a persistent gap between detection of bioactive molecules and proof of benefit in humans.

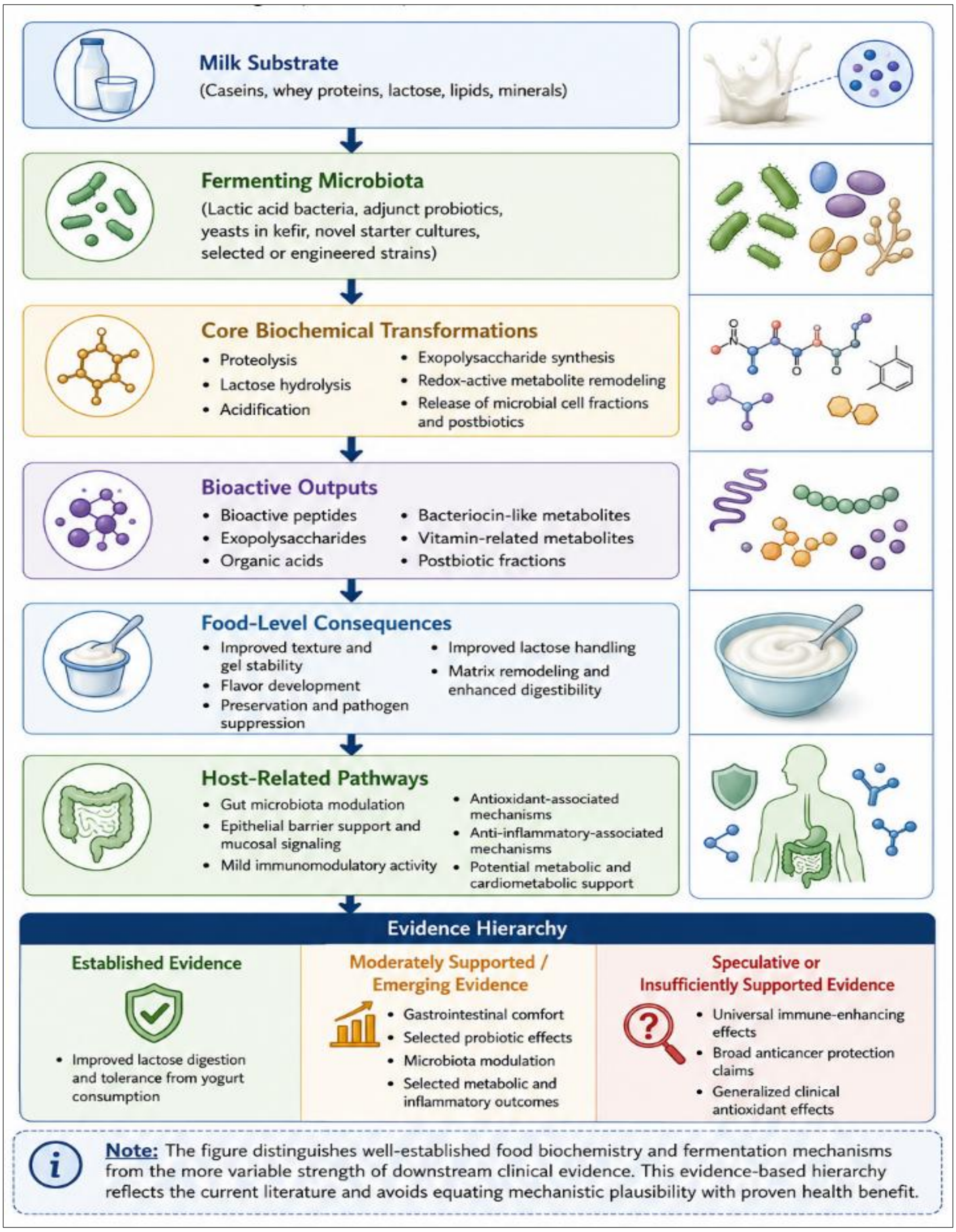

Fig 2: Formation of Bioactive Components During Dairy Fermentation and Their Potential Health Implications

6.1 Bioactive Peptides

Bioactive peptides are among the most extensively studied compounds generated during dairy fermentation. Produced mainly from caseins through microbial proteolysis, these peptides exhibit ACE-inhibitory, antioxidant, antimicrobial, immunomodulatory, and mineral-binding activities (Hayes *et al*., 2007; Korhonen, 2009; Choi, 2012; Park *et al*., 2015; Peres *et al*., 2024) [15, 18, 7, 26, 27]. While their biological activity is well established *in vitro*, evidence for consistent clinical benefits in humans remains limited due to uncertainties regarding bioavailability, stability, and dose-response relationships (Peres *et al*., 2024; Arslan *et al*., 2026) [27, 2].

6.2 Exopolysaccharides
Exopolysaccharides (EPS) produced by lactic acid bacteria contribute significantly to the texture, viscosity, and water-holding capacity of fermented dairy products (Saleem *et al*., 2024; Arslan *et al*., 2026) [31, 2]. Certain EPS, including kefiran, have also been associated with potential prebiotic and immunomodulatory properties (Lim *et al*., 2026) [20]. However, their technological importance is better established than their health benefits, which require further clinical validation (Arslan *et al*., 2026; Lim *et al*., 2026) [2, 20].

6.3 Organic Acids and Fermentation Metabolites
Fermentation generates organic acids such as lactic, acetic, citric, and succinic acids that contribute to acidification, preservation, flavor development, and inhibition of spoilage microorganisms (Saleem *et al*., 2024; Arslan *et al*., 2026) [31, 2]. Fermentation also alters the metabolite profile of dairy products, potentially influencing antioxidant properties. Nevertheless, evidence linking these metabolites to direct health benefits in humans remains limited (Arslan *et al*., 2026; Saleem *et al*., 2024) [2, 31].

6.4 Bacteriocins and Antimicrobial Compounds
Fermentation-associated microorganisms produce bacteriocins and other antimicrobial compounds that enhance product safety and shelf life by inhibiting spoilage and pathogenic microorganisms (Widyastuti *et al*., 2021; Saleem *et al*., 2024) [38, 31]. Although their role in food preservation is well recognized, evidence supporting direct antimicrobial effects following human consumption is currently insufficient (Arslan *et al*., 2026) [2].

6.5 Vitamins and Other Functional Compounds
Fermentation can modify vitamin profiles, particularly B-group vitamins, through microbial synthesis and metabolic activity (Saleem *et al*., 2024; Arslan *et al*., 2026) [31, 2]. However, these effects are highly dependent on microbial strains, product formulation, and processing conditions. Consequently, fermented dairy products should be viewed as variable functional food systems rather than uniformly vitamin-enriched foods (Zhang *et al*., 2020) [39].

Table 1: Classification, Characteristics, and Nutritional Attributes of Major Fermented Dairy Products

Product	Major Microorganisms	Fermentation Type	Key Nutritional/Bioactive Components	Reported Health Benefits
Yogurt	*S. thermophilus*, *L. delbrueckii* subsp. *bulgaricus*	Lactic acid fermentation	Protein, calcium, bioactive peptides, probiotics	Improved lactose digestion, gut health
Greek Yogurt	Yogurt starter cultures	Strained lactic fermentation	High protein, calcium, reduced lactose	Satiety, muscle health
Kefir	LAB, yeasts, acetic acid bacteria	Mixed lactic-alcoholic fermentation	Kefiran, probiotics, peptides, vitamins	Gut microbiota modulation, immune support
Dahi	Indigenous LAB	Traditional lactic fermentation	Peptides, probiotics, minerals	Improved digestibility, gut health
Kumis	LAB and yeasts	Lactic-alcoholic fermentation	Vitamins, organic acids, peptides	Digestive and antimicrobial benefits
Cultured Buttermilk	*Lactococcus* spp., *Leuconostoc* spp.	Mesophilic fermentation	Organic acids, phospholipids	Digestive support
Sour Cream	*Lactococcus* spp., *Leuconostoc* spp.	Cream fermentation	Milk fat, organic acids	Functional fermented dairy food
Skyr	Yogurt starter cultures	Strained fermentation	High protein, calcium	Satiety, muscle maintenance
Acidophilus Milk	*Lacticaseibacillus acidophilus*	Probiotic fermentation	Probiotics, organic acids	Intestinal microbial balance
Probiotic Fermented Milk	*Lactobacillus*, *Bifidobacterium* spp.	Probiotic fermentation	Live probiotics, bioactive metabolites	Gut and immune health
Synbiotic Dairy Products	Probiotics + prebiotics	Synbiotic fermentation	Probiotics, prebiotic substrates	Enhanced microbiome function
Postbiotic-Enriched Dairy Products	Fermentation-derived metabolites	Postbiotic enrichment	Peptides, EPS, microbial metabolites	Potential anti-inflammatory and immunomodulatory effects

7. Functional Properties and Health Benefits
The functional benefits of fermented dairy products arise from interactions among the dairy matrix, microorganisms, fermentation-derived metabolites, and host physiology. Evidence is strongest for improved lactose digestion, while benefits related to gut health, microbiota modulation, metabolic health, immunity, and inflammation show varying levels of support depending on product type, microbial composition, and study design (Savaiano & Hutkins, 2021; Bui *et al*., 2025; Arslan *et al*., 2026) [33, 6, 2].

7.1 Gut Health
Fermented dairy products, particularly yogurt and fermented milk, have been associated with improved gastrointestinal comfort, bowel function, and reduced digestive symptoms in several human studies (Bordoni *et al*., 2017; Chonnacháin *et al*., 2024; Sibanda *et al*., 2024) [5, 8, 37]. However, responses vary among individuals and products, indicating that benefits are not universal.

7.2 Modulation of Gut Microbiota
Evidence suggests that fermented dairy products can influence gut microbiota composition by increasing beneficial genera such as *Lactobacillus* and *Bifidobacterium* and, in some cases, enhancing microbial diversity (Chonnacháin *et al*., 2024; Sibanda *et al*., 2024; Bui *et al*., 2025) [8, 37, 6]. Nevertheless, the persistence and clinical significance of these changes remain uncertain (Gao *et al*., 2025) [13].

7.3 Probiotic Effects
Fermented dairy products serve as effective carriers for probiotics due to their protective food matrix. Clinical studies have shown that specific probiotic fermented dairy products can reduce infectious disease incidence and improve gastrointestinal comfort, although benefits are strain-specific and product-dependent (Poon *et al*., 2020; Eales *et al*., 2017; Savaiano & Hutkins, 2021) [28, 11, 33].

7.4 Immunomodulatory Activity
Fermented dairy products may influence immune function through microbial metabolites and fermentation-derived bioactive compounds. Experimental studies demonstrate strain-dependent effects on cytokine production, while human studies suggest potential reductions in infection risk and modulation of immune responses (Finnegan *et al*., 2024; Poon *et al*., 2020; Illikoud *et al*., 2022) [12, 28, 16].

7.5 Antioxidant Activity
Fermentation can generate peptides and metabolites with antioxidant properties, enhancing radical-scavenging and metal-chelating activities *in vitro* (Peres *et al*., 2024; Arslan *et al*., 2026) [27, 2]. However, evidence linking these biochemical effects to meaningful reductions in oxidative stress in humans remains limited (Saleem *et al*., 2024; Kaur, 2022; Arslan *et al*., 2026) [31, 17, 2].

7.6 Antimicrobial Activity
Lactic acid bacteria and other fermentation-associated microorganisms produce organic acids, bacteriocins, and antimicrobial metabolites that inhibit spoilage and pathogenic microorganisms, contributing to product safety and preservation (Widyastuti *et al*., 2021; Saleem *et al*., 2024; Kaur, 2022) [38, 31, 17]. Clinical evidence is limited, although probiotic fermented milk has shown benefits as an adjunct to *Helicobacter pylori* eradication therapy (Sachdeva *et al*., 2009) [30].

7.7 Anti-inflammatory Effects
Several studies suggest that fermented dairy products may reduce inflammatory markers and support immune homeostasis. Meta-analyses have reported reductions in C-reactive protein and favorable effects on selected immune biomarkers, although findings remain inconsistent across studies (Zhang *et al*., 2023; Bordoni *et al*., 2017) [40, 5].

7.8 Metabolic Health
Observational and clinical studies indicate that regular consumption of yogurt and other fermented dairy products may be associated with reduced risk of type 2 diabetes, metabolic syndrome, and improved metabolic profiles (Companys *et al*., 2020; Nestel *et al*., 2023; Savaiano & Hutkins, 2021) [9, 23, 33]. However, causal relationships require further confirmation through long-term intervention studies.

7.9 Cardiovascular Health
Current evidence suggests that fermented dairy products are generally neutral or favorable with respect to cardiovascular health. Prospective studies have linked yogurt and fermented milk consumption with modest reductions in cardiovascular disease risk, stroke, and hypertension (Companys *et al*., 2020; Drouin-Chartier *et al*., 2016; Astrup, 2019; Nestel *et al*., 2023) [9, 10, 3, 23].

7.10 Bone Health
Fermented dairy products provide calcium, phosphorus, and high-quality proteins that support bone metabolism. Emerging evidence suggests potential benefits for bone health through improved mineral utilization, microbiota modulation, and reduced inflammation, although direct evidence for fracture prevention remains limited (Rizzoli *et al*., 2018; Bashir *et al*., 2025; Savaiano & Hutkins, 2021) [29, 4, 33].

7.11 Lactose Intolerance Management
Improved lactose digestion is the most firmly established health benefit of fermented dairy products. Active yogurt cultures supply β-galactosidase, which enhances lactose digestion and tolerance in individuals with lactase deficiency (Savaiano *et al*., 1984; Martini *et al*., 1991; Savaiano, 2014; Savaiano & Hutkins, 2021) [35, 21, 32, 33]. This benefit is consistently supported by mechanistic and clinical evidence.

7.12 Potential Anticancer Effects
Epidemiological studies suggest that fermented dairy consumption may be associated with reduced risk of certain cancers, particularly colorectal cancer (Zhang *et al*., 2020; Liang *et al*., 2022; Guo *et al*., 2021) [39, 19, 14]. Proposed mechanisms include microbiota modulation, production of bioactive metabolites, and improved gut health. However, evidence remains largely observational, and definitive causal relationships have not been established (Savaiano & Hutkins, 2021) [33].

8. Fermented Dairy Products and the Gut Microbiome
The gut microbiome provides one of the most coherent frameworks for explaining how fermented dairy products may influence host health, but it is also a field in which mechanistic sophistication currently exceeds clinical certainty. Fermented dairy foods can affect the intestinal ecosystem through several non-exclusive routes: delivery of live microbes, exposure to microbial cell components, provision of fermentation-derived metabolites, altered digestibility of the dairy matrix, and changes in substrate availability to resident microbes (Gao *et al*., 2025; Bui *et al*., 2025; Arslan *et al*., 2026) [13, 6, 2].

A central concept is that fermented dairy microbes may not need to colonize permanently to exert functional effects. Transient passage through the gut may still alter luminal enzyme activity, interact with resident communities, or influence host epithelial and immune responses. This is particularly relevant to yogurt and probiotic fermented milks, where benefits such as improved lactose digestion or symptom relief can occur without durable microbial engraftment (Savaiano, 2014; Bordoni *et al*., 2017) [32, 5]. Current evidence therefore supports a model of functional interaction rather than one of universal colonization.

Short-chain fatty acids (SCFAs) are frequently invoked as mediators of gut-related benefits. Some human and animal studies report increases in fecal SCFAs after fermented dairy intake, and reviews increasingly discuss these metabolites as links between microbial fermentation, epithelial energy metabolism, mucosal integrity, and inflammatory regulation (Chonnacháin *et al*., 2024; Bui *et al*., 2025) [8, 6]. Yet the evidence remains mixed: some studies report increases, others report decreases or no change, and SCFA measurements are not always coupled to clinical outcomes. As a result, SCFA modulation should be considered an emerging mechanistic pathway rather than a settled endpoint.

The same caution applies to taxonomic shifts. Increased abundance of *Lactobacillus* or *Bifidobacterium* is often interpreted positively, but taxonomy alone does not fully capture function. Two interventions may produce similar genus-level changes while differing in metabolomic or immunological consequence. Modern reviews increasingly argue that the next phase of fermented dairy research must integrate multi-omics with symptom or biomarker endpoints rather than relying on compositional sequencing alone.

Mechanistically, several pathways appear especially credible. Fermented dairy products may stabilize epithelial barrier function, lower luminal pH, modulate mucosal immune signaling, affect bile-acid or peptide metabolism, and alter microbial cross-feeding networks. These mechanisms are biologically plausible and supported to varying degrees by *in vitro* and animal studies, but only some have robust human confirmation (Illikoud *et al*., 2022; Arslan *et al*., 2026; Gao *et al*., 2025) [16, 2, 13]. The field is therefore moving toward a more precise "precision fermented dairy" framework in which specific products are evaluated as targeted modulators of gut ecology and host physiology rather than as generic healthy foods.

Overall, the microbiome literature supports a nuanced conclusion. Fermented dairy products can modulate the gut environment and, in some settings, the microbiota itself. However, the magnitude, durability, and clinical meaning of these changes are highly context-dependent. The strongest current position is that microbiome modulation is an important explanatory mechanism for some fermented dairy effects, but it should not be treated as universal proof of benefit without corresponding human outcomes.

9. Technological Advances in Fermented Dairy Products

Technological advances have transformed fermented dairy products from traditional foods into platforms for delivering targeted health benefits and enhanced functionality. Probiotic fortification remains the most established approach, although maintaining microbial viability during processing and storage continues to be a major challenge. Increasing attention is also being given to postbiotic-enriched products, which offer improved stability and standardization compared with live probiotic formulations.

The development of synbiotic dairy products, combining probiotics with prebiotic substrates, has further expanded opportunities for gut health promotion, while functional ingredient enrichment has enabled the incorporation of fibers, antioxidants, minerals, and other bioactive compounds. In parallel, novel starter cultures are being selected not only for fermentation performance but also for their ability to produce desirable metabolites, bioactive peptides, and exopolysaccharides.

Recent innovations include precision fermentation, advanced encapsulation technologies, multi-omics-guided culture selection, and improved microbial viability assessment methods. These approaches support the development of next-generation fermented dairy products tailored for specific health outcomes, consumer preferences, and sustainability goals. However, despite rapid technological progress, further clinical validation is required to confirm the health benefits of many emerging products and formulations.

10. Consumer Acceptance and Market Trends

Consumer acceptance of fermented dairy products is influenced by health perceptions, product familiarity, and trust in food technologies. Traditional products such as yogurt, kefir, and dahi are widely perceived as natural and beneficial, particularly for digestive health and nutrition.

Growing consumer interest in gut health, functional foods, and wellness has increased demand for probiotic- and synbiotic-containing dairy products. At the same time, clean-label preferences have encouraged the use of recognizable ingredients and fermentation-based preservation strategies. However, acceptance of emerging technologies, including precision fermentation and advanced functional formulations, remains dependent on perceived safety, transparency, and authenticity.

The functional fermented dairy sector continues to expand globally, driven by increasing awareness of microbiome health and personalized nutrition. Nevertheless, consumption patterns vary across regions due to cultural preferences, dietary habits, and familiarity with specific fermented products. Future consumer expectations are likely to emphasize health benefits, clean labels, sustainability, transparency, and sensory quality. Consequently, effective communication and strong scientific substantiation will remain critical for successful product development and market adoption.

11. Sustainability Aspects

The sustainability of fermented dairy products should be evaluated across environmental, economic, and social dimensions. Fermentation can enhance shelf life, reduce food waste, and increase the value of dairy products, thereby improving resource utilization. It may also support circular bioeconomy approaches through the valorization of dairy by-products and side streams.

Economically, fermented dairy products represent important value-added foods with greater market differentiation and commercial potential (Afzaal *et al*., 2019) [1]. However, advanced functional formulations often require additional investments in strain selection, quality control, and product validation.

From a social perspective, fermented dairy products contribute to nutrition security by providing high-quality protein, calcium, and other essential nutrients in forms that are often more digestible and culturally acceptable. Their established role in lactose intolerance management further enhances their public health relevance.

Despite these advantages, sustainability benefits are not inherent to fermentation alone. Environmental impacts associated with milk production, processing, packaging, and refrigeration remain significant. Furthermore, successful commercialization depends on overcoming manufacturing challenges related to product stability, sensory quality, microbial viability, scalability, and cost-effectiveness. Therefore, the overall sustainability of fermented dairy products is highly dependent on production practices, technological efficiency, and consumer acceptance.

12. Future Perspectives

The future of fermented dairy products lies in the development of targeted, evidence-based foods designed to address individual nutritional and health needs. Advances in precision nutrition and microbiome science may enable personalized fermented dairy interventions based on gut microbiota composition, metabolic status, and disease risk.

Emerging innovations are expected to focus on microbiome-targeted products, postbiotic-enriched formulations, next-generation probiotics and synbiotics, and precision fermentation technologies. These approaches aim to enhance functionality, product stability, and health benefits while supporting sustainability goals.

Artificial intelligence and multi-omics technologies are likely to accelerate product development by improving strain selection, fermentation optimization, biomarker discovery, and mechanistic understanding of host-microbe interactions. Future clinical research should emphasize long-term, well-designed trials with standardized product characterization and clinically relevant outcomes. Collectively, these advances have the potential to transform fermented dairy products from traditional functional foods into personalized nutritional interventions supported by robust scientific evidence.

13. Research Gaps

Despite substantial progress, several research gaps remain in understanding the health effects of fermented dairy products. Clinical evidence is strongest for lactose digestion and selected probiotic benefits, while findings related to immunity, inflammation, metabolic health, and disease prevention require further validation. Variability in microbial composition, processing conditions, and product formulations limits study comparability and highlights the need for standardized characterization.

Current studies are predominantly short-term and often lack detailed information on microbial strains, viability, and bioactive metabolites. Moreover, microbiome research has focused largely on taxonomic changes, with limited investigation of microbial functionality and host responses. Future research should prioritize large-scale clinical trials, standardized methodologies, multi-omics approaches, precision nutrition strategies, functional microbiome analyses, and sustainability assessments. Addressing these gaps will strengthen the evidence base and support the development of scientifically validated fermented dairy products.

14. Conclusion

Fermented dairy products represent a unique convergence of traditional food processing, microbial biotechnology, and modern nutrition science. Through fermentation, milk is transformed into nutrient-rich foods containing beneficial microorganisms, bioactive peptides, organic acids, exopolysaccharides, and other health-promoting compounds. Current evidence strongly supports their role in improving lactose digestion and gastrointestinal health, while emerging research suggests potential benefits for gut microbiota modulation, cardiometabolic health, bone health, and immune function. Recent advances in probiotics, postbiotics, synbiotics, precision fermentation, and microbiome-focused product development have further expanded the functional potential of fermented dairy foods. However, variability in product composition, microbial strains, processing conditions, and study methodologies highlights the need for greater standardization and robust clinical validation. Overall, fermented dairy products remain a scientifically promising and rapidly evolving area of food and nutrition research, with future progress expected to be driven by precision nutrition, multi-omics technologies, and well-designed human intervention studies that support the development of safe, effective, and sustainable functional foods.

15. Declaration of Competing Interest

The author declares no known competing financial interests or personal relationships that could have influenced the work reported in this manuscript.

References

1. Afzaal M, Khan AU, Saeed F, Ahmed A, Ahmad MH, Maan AA, *et al*. Functional exploration of free and encapsulated probiotic bacteria in yogurt and simulated gastrointestinal conditions. Food Science & Nutrition. 2019;7(12):3931-3940.
2. Arslan BN, Döndaş NY, Koçhan S, Bulut SD, Tamer MA, Çelebioğlu HU, *et al*. Functional fermented dairy products: a review of mechanisms, health potential, and technological challenges. Frontiers in Nutrition. 2026;13:1779688.
3. Astrup A, Geiker NRW, Magkos F. Effects of full-fat and fermented dairy products on cardiometabolic disease: food is more than the sum of its parts. Advances in Nutrition. 2019;10(5):924S-930S.
4. Bashir HH, Hasnain MA, Abbas A, Lee JH, Moon GS. The impact of fermented dairy products and probiotics on bone health improvement. Food Science of Animal Resources. 2025;45(2):449.
5. Bordoni A, Danesi F, Dardevet D, Dupont D, Fernandez AS, Gille D, *et al*. Dairy products and inflammation: A review of the clinical evidence. Critical Reviews in Food Science and Nutrition. 2017;57(12):2497-2525.
6. Bui G, Marco ML. Impact of Fermented Dairy on Gastrointestinal Health and Associated Biomarkers. Nutrition Reviews. 2025;nuaf114.
7. Choi J, Sabikhi L, Hassan A, Anand S. Bioactive peptides in dairy products. International Journal of Dairy Technology. 2012;65(1):1-12.
8. Chonnacháin CN, Feeney EL, Gollogly C, Shields DC, Loscher CE, Cotter PD, *et al*. The effects of dairy on the gut microbiome and symptoms in gastrointestinal disease cohorts: a systematic review. Gut Microbiome. 2024;5:e5.
9. Companys J, Pla-Pagà L, Calderón-Pérez L, Llauradó E, Solà R, Pedret A, *et al*. Fermented dairy products, probiotic supplementation, and cardiometabolic diseases: a systematic review and meta-analysis. Advances in Nutrition. 11(4):834-863.
10. Drouin-Chartier JP, Brassard D, Tessier-Grenier M, Côté JA, Labonte ME, Desroches S, *et al*. Systematic review of the association between dairy product consumption and risk of cardiovascular-related clinical outcomes. Advances in Nutrition. 2016;7(6):1026-1040.
11. Eales J, Gibson P, Whorwell P, Kellow J, Yellowlees A, Perry RH, *et al*. Systematic review and meta-analysis: the effects of fermented milk with *Bifidobacterium lactis* CNCM I-2494 and lactic acid bacteria on gastrointestinal discomfort in the general adult population. Therapeutic Advances in Gastroenterology. 2017 Jan;10(1):74-88.
12. Finnegan D, Connolly C, Mechoud MA, FitzGerald JA, Beresford T, Mathur H, *et al*. Novel dairy fermentates

have differential effects on key immune responses associated with viral immunity and inflammation in dendritic cells. Foods. 2024;13(15):2392.
13. Gao Y, Liu Y, Ma T, Liang Q, Sun J, Wu X, *et al*. Fermented dairy products as precision modulators of gut microbiota and host health: Mechanistic insights, clinical evidence, and future directions. Foods. 2025;14(11):1946.
14. Guo LL, Li YT, Yao J, Wang LS, Chen WW, He KY, *et al*. Dairy Consumption and Risk of Conventional and Serrated Precursors of Colorectal Cancer: A Systematic Review and Meta-Analysis of Observational Studies. Journal of Oncology. 2021;2021:9948814.
15. Hayes M, Stanton C, Fitzgerald GF, Ross RP. Putting microbes to work: dairy fermentation, cell factories and bioactive peptides. Part II: bioactive peptide functions. Biotechnology Journal: Healthcare Nutrition Technology. 2007;2(4):435-449.
16. Illikoud N, Mantel M, Rolli-Derkinderen M, Gagnaire V, Jan G. Dairy starters and fermented dairy products modulate gut mucosal immunity. Immunology Letters. 2022;251:91-102.
17. Kaur H, Kaur G, Ali SA. Dairy-based probiotic-fermented functional foods: An update on their health-promoting properties. Fermentation. 2022;8(9):425.
18. Korhonen H. Milk-derived bioactive peptides: From science to applications. Journal of Functional Foods. 2009;1(2):177-187.
19. Liang Z, Song X, Hu J, Wu R, Li P, Dong Z, *et al*. Fermented dairy food intake and risk of colorectal cancer: a systematic review and meta-analysis. Frontiers in Oncology. 2022;12:812679.
20. Lim JJL, Chin NL, Chong CW, Ripen AM, How S, Teoh SQ. Review on kefir beverages from milk and water: health benefits, processing and applications. Food Science of Animal Resources. 2026 Dec;46(1):31.
21. Martini MC, Kukielka D, Savaiano DA. Lactose digestion from yogurt: influence of a meal and additional lactose. The American Journal of Clinical Nutrition. 1991;53(5):1253-1258.
22. Nagpal R, Behare PV, Kumar M, Mohania D, Yadav M, Jain S, *et al*. Milk, milk products, and disease free health: an updated overview. Critical Reviews in Food Science and Nutrition. 2012;52(4):321-333.
23. Nestel PJ, Mori TA. Dairy Foods: Beneficial Effects of Fermented Products on Cardiometabolic Health. Current Nutrition Reports. 2023 Sep;12(3):478-485.
24. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, *et al*. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372.
25. Pang L, Huang Y, Li R, Guo L, Man C, Yang X, *et al*. Effects of postbiotics produced by *Lactobacillus plantarum* JM015 isolated from traditional fermented dairy products on *Salmonella*-induced intestinal inflammation: A preventive strategy. Food Chemistry. 2025;469:142549.
26. Park YW, Nam MS. Bioactive peptides in milk and dairy products: a review. Korean Journal for Food Science of Animal Resources. 2015;35(6):831.
27. Peres Fabbri L, Cavallero A, Vidotto F, Gabriele M. Bioactive peptides from fermented foods: Production approaches, sources, and potential health benefits. Foods. 2024;13(21):3369.
28. Poon T, Juana J, Noori D, Jeansen S, Pierucci-Lagha A, Musa-Veloso K. Effects of a fermented dairy drink containing *Lacticaseibacillus paracasei* subsp. *paracasei* CNCM I-1518 (*Lactobacillus casei* CNCM I-1518) and the standard yogurt cultures on the incidence, duration, and severity of common infectious diseases: a systematic review and meta-analysis of randomized controlled trials. Nutrients. 2020;12(11):3443.
29. Rizzoli R, Biver E. Effects of fermented milk products on bone. Calcified Tissue International. 2018;102(4):489-500.
30. Sachdeva A, Nagpal J. Effect of fermented milk-based probiotic preparations on *Helicobacter pylori* eradication: a systematic review and meta-analysis of randomized-controlled trials. European Journal of Gastroenterology & Hepatology. 2009;21(1):45-53.
31. Saleem GN, Gu R, Qu H, Bahar Khaskheli G, Rashid Rajput I, Qasim M, *et al*. Therapeutic potential of popular fermented dairy products and its benefits on human health. Frontiers in Nutrition. 2024;11:1328620.
32. Savaiano DA. Lactose digestion from yogurt: mechanism and relevance. The American Journal of Clinical Nutrition. 2014;99(5):1251S-1255S.
33. Savaiano DA, Hutkins RW. Yogurt, cultured fermented milk, and health: A systematic review. Nutrition Reviews. 2021;79(5):599-614.
34. Savaiano DA, Levitt MD. Milk intolerance and microbe-containing dairy foods. Journal of Dairy Science. 1987;70(2):397-406.
35. Savaiano DA, AbouElAnouar A, Smith DE, Levitt MD. Lactose malabsorption from yogurt, pasteurized yogurt, sweet acidophilus milk, and cultured milk in lactase-deficient individuals. The American Journal of Clinical Nutrition. 1984;40(6):1219-1223.
36. Shiby VK, Mishra HN. Fermented milks and milk products as functional foods—A review. Critical Reviews in Food Science and Nutrition. 2013;53(5):482-496.
37. Sibanda T, Marole TA, Thomashoff UL, Thantsha MS, Buys EM. *Bifidobacterium* species viability in dairy-based probiotic foods: challenges and innovative approaches for accurate viability determination and monitoring of probiotic functionality. Frontiers in Microbiology. 2024;15:1327010.
38. Widyastuti Y, Febrisiantosa A, Tidona F. Health-promoting properties of lactobacilli in fermented dairy products. Frontiers in Microbiology. 2021;12:673890.
39. Zhang K, Chen X, Zhang L, Deng Z. Fermented dairy foods intake and risk of cardiovascular diseases: a meta-analysis of cohort studies. Critical Reviews in Food Science and Nutrition. 2020;60(7):1189-1194.
40. Zhang X, Luo Q, Guan X, Tang Y, Chen X, Deng J, *et al*. Effects of fermented dairy products on inflammatory biomarkers: A meta-analysis. Nutrition, Metabolism and Cardiovascular Diseases. 2023;33(3):471-482.