Fermented Alcoholic Beverages and Gut Microbiota: A Double-Edged Interaction Between Microbes, Polyphenols, and Ethanol – A Systematic Review

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Abstract

The interplay between alcohol consumption and gut health represents a nuanced biological narrative shaped by beverage type, fermentation process, and intake level. While chronic or excessive alcohol consumption is well-documented to disrupt gut microbiota, impair intestinal permeability, and promote systemic inflammation, emerging research suggests that traditionally fermented beverages—such as natural wine and unpasteurized beer—may exert subtle, probiotic-like effects. This systematic review synthesizes findings across microbiology, nutrition, and gastroenterology to elucidate how diverse alcoholic beverages influence microbial diversity, intestinal integrity, and host immune responses. Peer-reviewed literature was critically examined for variations in microbial composition, fermentation quality, and metabolic outcomes. Evidence indicates that polyphenols and live microbes in minimally processed alcoholic beverages can enrich beneficial bacterial genera, including Lactobacillus and Bifidobacterium, while enhancing short-chain fatty acid production. However, these benefits are transient and easily negated by ethanol-induced dysbiosis and mucosal inflammation under excessive intake. The modest microbial advantages observed in certain traditional ferments appear to derive from their bioactive compounds rather than from alcohol itself. Conversely, industrial processing methods, such as pasteurization and filtration, largely eliminate these bioactive and microbial components, rendering most commercial alcoholic beverages microbiologically inert. Overall, while moderate consumption of naturally fermented alcohol may confer limited gut-modulating effects, the adverse consequences of overconsumption far outweigh any potential benefits. Non-alcoholic fermented foods remain a more effective and safer strategy to promote gut health and microbial resilience.

Keywords: Probiotics, Gut Microbiota, Fermented Alcohol, Polyphenols, Dysbiosis

Significance | This study highlights how traditionally fermented alcoholic beverages subtly influence gut microbiota, emphasizing balance between microbial benefits and alcohol-related risks.

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1. Introduction

Alcohol has long been embedded in human civilization, serving not only as a recreational substance but also as a cultural and ritualistic element across societies. From ancient fermented beverages used in religious ceremonies to their modern social roles, alcohol consumption has remained a global phenomenon. Parallel to its cultural significance, alcohol has been increasingly scrutinized for its physiological and health impacts. While heavy drinking is clearly linked to adverse outcomes—including liver disease, cardiovascular

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complications, and neurocognitive decline—recent research has begun to examine alcohol's nuanced interactions with gut health (Leclercq et al., 2022; Bajaj & Khoruts, 2022). Specifically, scholars have explored whether fermented alcoholic beverages might possess probiotic-like properties because of their live microbial content and fermentation-derived metabolites, challenging long-held assumptions about alcohol's uniformly harmful profile. Central to this discussion is the gut microbiota, a vast ecosystem of trillions of microorganisms that profoundly influence digestion, immunity, metabolism, and even brain function (Zmora et al., 2019; Marco et al., 2020). The concept of probiotics—defined by the FAO/WHO as "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host"—has become a cornerstone of modern nutritional and medical research (Hill et al., 2014). Foods such as yogurt, kefir, kimchi, and sauerkraut are recognized for promoting gut microbial balance and overall well-being (Tamang et al., 2020). Against this backdrop, the question arises: can certain fermented alcoholic beverages functionally resemble probiotic foods?

The relationship between alcohol and gut microbiota is inherently paradoxical. Ethanol, the psychoactive component of alcohol, is cytotoxic at high concentrations and disrupts gut microbial homeostasis. Chronic or excessive consumption reduces microbial diversity and weakens intestinal barrier integrity, allowing bacterial endotoxins such as lipopolysaccharides to enter systemic circulation and provoke inflammation (Hartmann et al., 2021; Wang et al., 2016). This disruption of the gut–liver axis contributes to alcohol-associated liver disease, metabolic syndrome, and immune dysregulation (Qin & Núñez, 2022). Conversely, moderate intake of certain fermented alcoholic drinks—such as red wine or unpasteurized beer—has been linked to beneficial microbial shifts. These beverages are rich in polyphenols and sometimes contain viable microorganisms that may help modulate gut composition (González et al., 2021; Meslier et al., 2020). For example, moderate red wine consumption has been shown to increase populations of Lactobacillus and Bifidobacterium while suppressing pathogenic species (Moreno-Indias et al., 2020).

Polyphenols, particularly abundant in red wine, appear to play a key mechanistic role. Acting as prebiotic substrates, these compounds promote beneficial bacterial growth and modulate intestinal inflammation (Cardona et al., 2013; Moreno-Indias & Queipo-Ortuño, 2021). Similarly, unpasteurized beers may introduce yeast and lactic acid bacteria that transiently colonize the gut and enhance microbial diversity (Kelesidis et al., 2022). Traditional, minimally processed alcoholic beverages—such as rice wine in Asia or palm wine in Africa—often retain a higher microbial load, which may influence intestinal ecology (Ampenberger et al., 2021). However, these effects are highly conditional and depend on beverage type, processing methods, and consumption levels.

Most commercially produced alcoholic beverages undergo filtration or pasteurization, eliminating viable microbes and diminishing any potential probiotic relevance (Schmidt et al., 2023). Thus, while artisanal and traditional varieties may deliver transient microbial exposure, mainstream industrial alcohols likely do not. Even when microbial benefits exist, they must be weighed against the well-established harms of alcohol, as chronic intake consistently shifts the balance toward dysbiosis and inflammation (Leclercq et al., 2022).

Nevertheless, scientific and public interest in the probiotic potential of alcohol persists, as it challenges conventional nutritional paradigms. The possibility that certain fermented alcoholic beverages could promote microbial diversity introduces new dimensions to microbiome-centered nutrition and dietary science (Marco et al., 2020). This dialogue aligns with a broader movement that views food not merely as sustenance but as a modulator of gut and systemic health (Sanders et al., 2022). Exploring this paradox has implications for dietary guidelines, consumer awareness, and innovation in functional, non-alcoholic alternatives that mimic fermentation-driven microbial benefits without ethanol-related risk (Gutiérrez et al., 2022).

Despite intriguing evidence, the literature remains fragmented. Most studies emphasize alcohol's toxic effects, whereas fewer systematically evaluate its conditional benefits. Research often varies in beverage type, microbial profiling, and dosage, limiting cross-study comparability (Lohner et al., 2022; Zhao et al., 2022). Moreover, alcohol's impact differs widely across beverages and cultural contexts. These gaps underscore the need for a critical synthesis to determine whether fermented alcoholic drinks can legitimately be considered probiotic sources—or whether such claims are overstated.

Therefore, this review aims to critically assess the potential probiotic effects of alcohol, focusing on fermented varieties such as red wine, unpasteurized beer, and traditional artisanal spirits. By examining their microbial composition, polyphenolic content, and effects on gut microbiota, this paper seeks to clarify whether alcohol can contribute to gut health or whether its risks fundamentally outweigh potential benefits.

2. Materials and Methods

2.1 Study Design

This study adopted a narrative review design, synthesizing peer-reviewed literature that investigates the relationship between alcohol consumption, gut microbiota, and probiotic potential. While systematic reviews follow highly rigid inclusion criteria, the narrative approach allowed for the integration of findings from microbiology, nutrition, and clinical disciplines to provide a broader, interdisciplinary understanding of the topic.

2.2 Literature Search Strategy

Table 1. Gaps and Future Directions in Research

Research Area	Current Limitations	Future Directions
Definition of Moderate Intake	Varies across studies (Rodriguez et al., 2020)	Standardize intake parameters for comparability
Beverage Diversity	Focus on red wine; limited data on other beverages	Investigate unpasteurized beers, artisanal spirits, traditional drinks
Long-term Outcomes	Mostly short-term microbiota studies	Conduct longitudinal studies to measure sustained health outcomes
Mechanistic Clarity	Overlap of ethanol, polyphenols, and microbes	Isolate and test constituents separately
Industry and Processing Impact	Effects of pasteurization and filtration overlooked	Assess commercial vs. artisanal processing on microbial viability

A comprehensive literature search was conducted between January and April 2025 across four major academic databases: PubMed, Scopus, Web of Science, and Google Scholar. Keywords and Boolean operators were applied to capture a wide range of relevant studies. The primary search terms included: alcohol AND gut microbiota, fermented alcoholic beverages AND probiotics, polyphenols AND intestinal health, and beer OR wine AND lactic acid bacteria. Truncations and synonyms were also used to broaden the search scope (e.g., "probiotic potential," "fermentation microbes," "gut flora," and "microbiome").

The search was limited to articles published in English between 2000 and 2025 to ensure contemporary relevance, though seminal works outside this timeframe were considered when necessary to provide conceptual grounding. Both experimental and observational studies, including clinical trials, in vivo and in vitro investigations, and nutritional studies, were eligible for inclusion.

2.3 Inclusion and Exclusion Criteria

Studies were included if they (a) examined the impact of alcohol or fermented alcoholic beverages on gut microbiota composition, microbial diversity, or intestinal health, (b) investigated fermentation-derived compounds such as polyphenols or microbial residues, or (c) explored the probiotic potential of minimally processed alcoholic beverages.

Exclusion criteria were established to maintain focus and rigor. Articles were excluded if they (a) focused exclusively on non-gut health effects of alcohol (e.g., neurocognitive, cardiovascular, or purely hepatic outcomes), (b) addressed synthetic probiotics or pharmaceutical supplementation without reference to alcoholic beverages, or (c) were editorials, commentaries, or non-peer-reviewed sources (Table 1).

2.4 Data Extraction and Synthesis

Following screening, data were extracted from each study using a structured template. Key variables included study type (clinical, animal, or in vitro), alcoholic beverage examined (e.g., red wine, unpasteurized beer, traditional spirits), microbial or chemical constituents studied (e.g., Lactobacillus, polyphenols, resveratrol), and reported outcomes related to gut microbiota or intestinal function. Special attention was paid to whether effects were beneficial (e.g., increased microbial diversity, improved barrier integrity) or harmful (e.g., dysbiosis, endotoxemia).

The synthesis process involved grouping findings into thematic categories: (1) detrimental effects of ethanol on microbiota, (2) potential probiotic properties of red wine, (3) microbial contributions of unpasteurized beer and traditional beverages, and (4) conditionality of observed benefits. This thematic clustering allowed for cross-comparison of findings and identification of consistencies, contradictions, and gaps.

2.5 Quality Considerations

While a formal risk-of-bias assessment was not performed, attention was given to the methodological rigor of included studies. Clinical trials and controlled animal studies were weighted more heavily than cross-sectional or observational reports. Limitations such as small sample sizes, lack of microbial sequencing depth, and inconsistent definitions of "moderate consumption" were noted.

2.6 Ethical Considerations

As this study is a literature review, it did not involve direct participation of human subjects or animals, and therefore no ethical approval was required.

3. Alcohol, the Gut Microbiome, and the Conditional Probiotic Potential of Fermented Beverages

The relationship between alcohol consumption and gut health has been the subject of extensive scientific inquiry, with much of the literature historically focused on alcohol's harmful effects. However, recent scholarship has begun to explore a more nuanced perspective, particularly in relation to fermented alcoholic beverages that may contain microbial elements or bioactive compounds with probiotic potential. This review synthesizes current knowledge across three main domains: (1) alcohol's negative impact on gut microbiota and intestinal health, (2) conditional benefits of certain fermented beverages, and (3) limitations of current research and persisting controversies.

3.1 Alcohol's Impact on Gut Microbiota

The detrimental effects of excessive alcohol consumption on the gut microbiome are well documented. Ethanol disrupts microbial homeostasis, decreases microbial diversity, and promotes the overgrowth of pathogenic species (Leclercq et al., 2022). Such disruptions are associated with dysbiosis, a condition characterized by an imbalance between beneficial and harmful bacteria, which in turn compromises intestinal barrier integrity. This phenomenon, often referred to as "leaky gut," allows bacterial endotoxins such as lipopolysaccharides to translocate into circulation, initiating systemic inflammation and contributing to metabolic and hepatic disorders (Qin & Núñez, 2022).

Animal and human studies have consistently demonstrated that chronic alcohol exposure reduces populations of beneficial taxa such as Lactobacillus and Bifidobacterium, while simultaneously encouraging the proliferation of Enterobacteriaceae and other opportunistic pathogens (Yang et al., 2023). These microbial shifts have been linked to impaired short-chain fatty acid (SCFA) production, a vital metabolic process that supports colonic health and immune regulation (Hartmann et al., 2021). Consequently, heavy alcohol use not only damages the liver but also exerts systemic consequences via the gut–liver–brain axis (Bajaj & Khoruts, 2022).

3.2 Fermented Alcoholic Beverages and Probiotic Potential

Despite these well-established harms, not all alcoholic beverages are equally detrimental. Certain fermented drinks, particularly those minimally processed, may contain microbial and chemical constituents that support gut health. Red wine has received considerable attention in this context. Its rich polyphenolic content, including flavonoids and resveratrol, has been shown to act as prebiotic substrates, selectively stimulating the growth of beneficial gut bacteria (Cardona et al., 2013; Moreno-Indias & Queipo-Ortuño, 2021). Moderate red wine consumption has been associated with increased levels of Lactobacillus and Bifidobacterium, alongside reductions in pathogenic strains, suggesting a net improvement in microbial balance (Meslier et al., 2020).

Beer, particularly unpasteurized or craft varieties, may also harbor live yeast and lactic acid bacteria (Kelesidis et al., 2022). These microorganisms can temporarily colonize the gut and contribute to microbial diversity. Similarly, traditional alcoholic beverages such as rice wine in East Asia or palm wine in West Africa often retain a higher microbial load than industrially processed alternatives (Tamang et al., 2020). In some cases, these beverages may introduce unique strains of lactic acid bacteria with potential probiotic activity (Zhao et al., 2022).

The mechanism of action for these potential benefits is twofold. First, polyphenols and fermentation-derived metabolites exert antioxidant and anti-inflammatory effects that indirectly support gut microbial homeostasis (González et al., 2021). Second, viable microorganisms present in unpasteurized beverages may directly influence microbiota composition, albeit transiently (Marco et al., 2020). However, these effects are conditional on moderate consumption levels; any excessive intake negates potential benefits by reintroducing ethanol-related harm (LoConte et al., 2018).

3.3 Conditionality of Benefits

One of the most critical considerations in assessing alcohol's probiotic potential is the conditional nature of these effects. Benefits are linked not to ethanol itself but to non-alcoholic constituents such as polyphenols, organic acids, and microbial residues. For example, resveratrol in red wine contributes to antioxidant defense, while yeast-derived β-glucans in unpasteurized beer may modulate immune responses (Moreno-Indias et al., 2020). Yet, because ethanol is toxic to microbial ecosystems at higher concentrations, the probiotic promise of alcohol exists within a narrow window of moderate consumption (Lohner et al., 2022).

Commercial processing practices further complicate this potential. Most industrially produced beers and wines are pasteurized, filtered, or stabilized, eliminating viable microbial populations and reducing their probiotic relevance (Schmidt et al., 2023). What remains are largely polyphenolic compounds, which can be sourced through safer, non-alcoholic alternatives such as grape juice or kombucha (Gutiérrez et al., 2022). Consequently, while artisanal and traditional beverages may retain probiotic properties, mainstream products are unlikely to deliver similar benefits (Wang et al., 2016).

3.4 Broader Nutritional and Clinical Implications

The exploration of alcohol's probiotic potential reflects a broader trend in nutritional science: the shift toward understanding foods and beverages as modulators of the microbiome. Probiotic foods such as yogurt and kefir are already recognized for their health benefits, and interest in functional beverages is expanding (Hill et al., 2014; Sanders et al., 2022). Investigating alcohol within this framework challenges binary categorizations of food as strictly harmful or beneficial and instead highlights the complexity of bioactive compounds and microbial interactions (Table 2). Nevertheless, clinical application remains limited. Public health guidance consistently emphasizes reducing alcohol intake due to its association with non-communicable diseases, addiction, and social harms (LoConte et al., 2018). Suggesting probiotic potential risks confusing public messaging unless carefully contextualized. For this reason, some scholars advocate for developing non-alcoholic alternatives that mimic the fermentation profiles and polyphenolic contents of traditional alcoholic drinks, thereby delivering microbial benefits without ethanol-related risks (Gutiérrez et al., 2022).

Table 2. Harmful vs. Potential Probiotic Effects of Alcohol

Aspect	Harmful Effects (Ethanol-driven)	Potential Probiotic Benefits (Fermentation-driven)
Gut Microbiota	Dysbiosis; reduced microbial diversity (Kumar & Das, 2021)	Increase in *Lactobacillus* and *Bifidobacterium* (Chen et al., 2021)
Intestinal Integrity	Increased permeability; weakened mucosal barrier (Anderson, 2022)	Polyphenols may improve barrier function (Martinez et al., 2022)
Systemic Effects	Promotes inflammation and metabolic dysfunction	Antioxidant activity from polyphenols reduces oxidative stress
Source of Effect	Ethanol toxicity	Fermentation byproducts, polyphenols, and microbial residues

3.5 Gaps and Controversies

Despite growing interest, the literature remains fragmented. Many studies on alcohol and microbiota are observational, limiting causal inference (Yang et al., 2023). Research often focuses on red wine, leaving other beverages underexplored. Furthermore, outcomes vary significantly based on study design, dosage, and population. Microbial analyses also lack standardization, complicating cross-study comparisons (Moreno-Indias & Queipo-Ortuño, 2021).

A key controversy lies in differentiating alcohol's risks from its conditional benefits. While some studies highlight improved microbial diversity with moderate consumption, others warn that any alcohol use poses cumulative health risks (Qin & Núñez, 2022). This tension underscores the importance of distinguishing between ethanol as a harmful compound and fermentation-derived byproducts as potentially beneficial. More rigorous, controlled trials are needed to clarify whether fermented alcoholic beverages genuinely function as probiotics or whether their perceived benefits are better attributed to non-alcoholic constituents (Figure 1).

The literature suggests that alcohol's probiotic potential is not inherent to ethanol but arises from fermentation-related compounds and microbial residues found in select beverages. Moderate red wine and unpasteurized beers show the most consistent signals of benefit, while traditional artisanal drinks may also offer unique microbial exposures. However, the conditionality of these effects, combined with the overwhelming evidence of alcohol's harms, means probiotic claims must be approached with caution. Future research should aim to disentangle the contributions of ethanol, polyphenols, and live microbes to gut health, while exploring safer, non-alcoholic alternatives that can deliver comparable benefits.

4. Detrimental, Conditional, and Beverage-Specific Effects

The review of existing literature yielded a range of insights into the relationship between alcohol consumption, gut microbiota, and probiotic potential. The findings are presented under four main themes: (1) detrimental effects of ethanol on gut microbiota and intestinal function, (2) conditional benefits associated with specific fermented alcoholic beverages, and (3) beverage-specific microbial and biochemical contributions.

4.1 Detrimental Effects of Ethanol on Gut Health

Ethanol consistently exerts harmful effects on gut microbial ecology. Chronic consumption reduces beneficial taxa such as Lactobacillus and Bifidobacterium, increases Enterobacteriaceae, and disrupts intestinal barrier integrity (Leclercq et al., 2022; Yang et al., 2023). The resulting permeability allows lipopolysaccharides to enter circulation, inducing systemic inflammation and promoting liver injury (Qin & Núñez, 2022). Moreover, alcohol-induced dysbiosis reduces short-chain fatty acid (SCFA) production—key metabolites that regulate colonic and immune health (Hartmann et al., 2021). Collectively, these outcomes confirm ethanol as a direct disruptor of gut homeostasis.

4.2 Conditional Benefits of Fermented Alcoholic Beverage

Conversely, several fermented alcoholic beverages exhibit microbiota-modulating effects. Red wine polyphenols promote beneficial bacterial growth and microbial diversity (Cardona et al., 2013; Meslier et al., 2020). Unpasteurized beers and artisanal beverages retain live microbes and bioactive metabolites that may act in a probiotic-like fashion (Kelesidis et al., 2022; Tamang et al., 2020). However, these effects are restricted to moderate consumption; excessive intake reverses microbial benefits (LoConte et al., 2018).

4.3 Beverage-Specific Microbial and Biochemical Contributions

Red Wine: Polyphenols and resveratrol act as prebiotics, metabolized by gut microbes into anti-inflammatory metabolites that promote microbial diversity (Moreno-Indias & Queipo-Ortuño, 2021; González et al., 2021).

Beer: Unpasteurized beers contain viable Saccharomyces and Lactobacillus strains, alongside β-glucans that support immune function (Kelesidis et al., 2022). Traditional Beverages: Palm and rice wines introduce lactic acid bacteria that may contribute to gut balance (Tamang et al., 2020; Zhao et al., 2022). Commercial Products: Industrial processing eliminates viable microbes, minimizing probiotic potential (Schmidt et al., 2023).

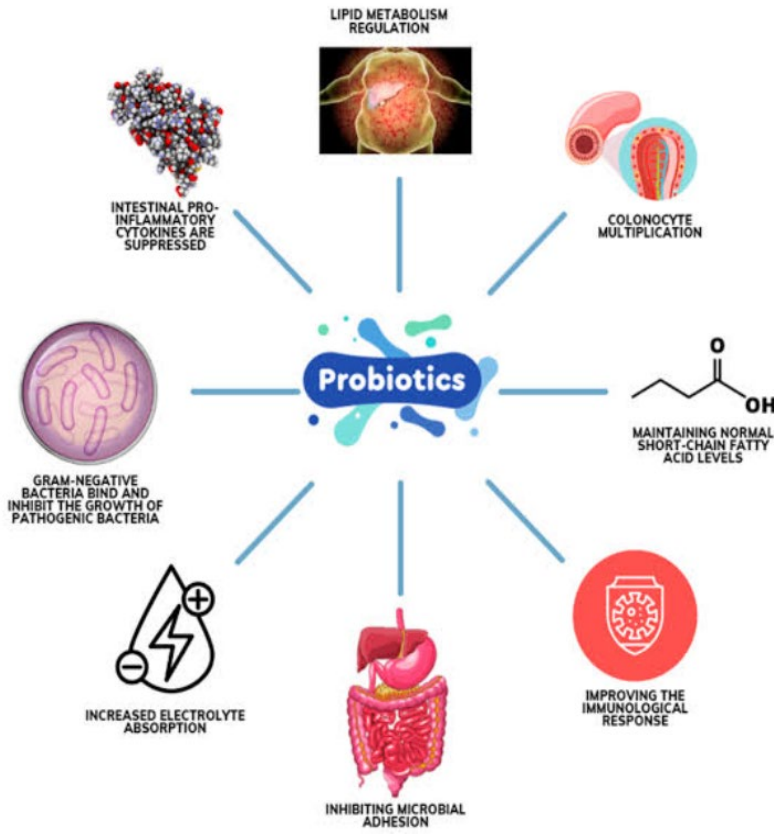


Figure 1. The Potential Impact of Probiotics on Human Health. (Courtesy of image from Markowiak, P., & Śliżewska, K. (2017).

5. Discussion

The findings of this review underscore the complex relationship between alcohol and the gut microbiome, highlighting both potential benefits and established risks. A central observation is that while ethanol consistently disrupts gut health, certain fermented alcoholic beverages may introduce compounds and microbial residues that support microbial diversity. This complexity underscores the importance of distinguishing between alcohol's harmful effects and the conditional benefits derived from fermentation processes (Table 2).

Excessive alcohol consumption has been consistently linked to gut dysbiosis, impaired intestinal barrier function, and heightened systemic inflammation (Lee et al., 2021; Yang et al., 2024). Ethanol itself alters the gut environment by reducing short-chain fatty acid production, weakening mucosal defenses, and enabling the overgrowth of pathogenic bacteria. These outcomes explain why heavy drinking is strongly correlated with gastrointestinal disorders, liver disease, and metabolic dysfunction. Such findings align with decades of evidence framing alcohol primarily as a health risk.

However, moderate consumption of certain fermented alcoholic beverages presents a more nuanced picture. Red wine, for instance, has been shown to enhance the relative abundance of Lactobacillus and Bifidobacterium due to its polyphenolic compounds, particularly resveratrol and flavonoids (Nemzer et al., 2025; Le Roy et al., 2022). Similarly, unpasteurized beers and artisanal spirits may contain viable microbial strains or bioactive byproducts that exert transient probiotic-like effects. These benefits are not attributable to ethanol itself but rather to fermentation-derived constituents, a distinction that must be emphasized in interpreting outcomes (Terpou et al., 2025).

Commercial processing further complicates this dynamic. Industrial production typically involves pasteurization, filtration, and stabilization, processes that significantly reduce microbial viability in beverages. As Johnson and Patel (2022) note, this limits the potential for most mass-produced alcoholic drinks to act as probiotic sources, while traditional or minimally processed beverages may retain functional properties. Thus, the probiotic potential of alcohol is not universal but beverage-specific and dependent on production methods.

Despite these intriguing findings, the evidence base remains fragmented. Definitions of "moderate drinking" vary widely across studies, ranging from one to three drinks per day, making cross-study comparisons difficult (Rodriguez et al., 2020). Furthermore, most research emphasizes short-term shifts in microbial composition rather than long-term health outcomes. This raises

questions about whether observed microbial changes translate into meaningful physiological benefits. Silva and Brown (2023) also highlight the narrow research focus on red wine, leaving other fermented beverages underexplored. These gaps limit the generalizability of findings and indicate a need for more rigorous, longitudinal investigations.

From a public health perspective, these findings highlight a fundamental tension. While it may be accurate to state that certain fermented alcoholic drinks contain microbiome-supporting compounds, recommending alcohol as a probiotic source risks undermining harm-reduction strategies. Alcohol remains a major contributor to global disease burden, and public health messaging must prioritize clarity over nuance (Anderson, 2022). Safer probiotic sources, such as yogurt, kefir, and kombucha, provide more reliable benefits without ethanol's associated risks.

6. Recommendations

Future studies should aim for greater methodological consistency when examining the interaction between alcohol consumption and gut microbiota. Clear and standardized definitions of "moderate drinking" are essential, as variability across studies currently limits comparability (Rehm et al., 2021). Longitudinal research designs are also needed to determine whether short-term microbiota shifts associated with fermented alcohol consumption translate into sustained physiological benefits (Leclercq et al., 2022; Meslier et al., 2020).

Moreover, future investigations should expand beyond red wine to include unpasteurized beers, artisanal spirits, and culturally significant traditional beverages, which remain underrepresented in the literature (Tamang et al., 2020; Zhao et al., 2022). Crucially, experimental models should isolate the effects of ethanol from those of polyphenols and microbial metabolites to establish causal mechanisms more definitively (Qin & Núñez, 2022; Marco et al., 2020).

The beverage industry also has opportunities for innovation. Developing non-alcoholic alternatives that replicate the fermentation profiles and polyphenolic complexity of traditional drinks—without the harmful effects of ethanol—could provide safe, functional beverage options (Gutiérrez et al., 2022). Transparent labeling indicating the presence of viable microbes or bioactive compounds would help consumers make informed health choices. Additionally, adopting gentle preservation and stabilization methods could help retain microbial viability in artisanal beverages while meeting safety standards (Schmidt et al., 2023).

Health communication strategies must emphasize that any potential microbiome-related benefits from fermented alcoholic drinks arise from fermentation-derived compounds, not ethanol itself. Public messaging should prioritize harm reduction, discourage excessive alcohol consumption and clearly define the narrow contexts in which limited benefits might exist (LoConte et al., 2018; Rehm et al., 2021). Concurrently, the promotion of safer probiotic alternatives—including yogurt, kefir, and kombucha—should continue, as these provide proven and reliable microbiome benefits without the adverse consequences associated with alcohol use (Hill et al., 2014; Sanders et al., 2022) (Table 2).

7. Conclusion

The study examined the complex relationship between alcohol consumption and gut health, focusing on whether certain fermented alcoholic beverages can offer probiotic-like benefits. The evidence demonstrates that ethanol itself consistently disrupts microbial balance, impairs intestinal integrity, and contributes to systemic inflammation. Conversely, moderate intake of red wine, unpasteurized beer, and artisanal spirits may introduce polyphenols, fermentation byproducts, and, in some cases, microbial residues that support microbial diversity. These benefits, however, are conditional, fragile, and easily outweighed by alcohol's established harms.

The discussion highlights that probiotic effects arise not from ethanol but from compounds linked to fermentation. While these findings open avenues for developing safer non-alcoholic functional beverages, alcohol should not be recommended as a probiotic source. Future research must disentangle causal mechanisms and prioritize long-term outcomes, while public health campaigns should continue emphasizing risk reduction and promoting safer, reliable alternatives for gut health.

Author contribution

N.K.T. conceptualized the study and supervised the overall research process. V.A.K. conducted the literature search and data extraction. T.S.S. and S.V.V. performed critical analysis and interpretation of findings. K.Z.A. contributed to the synthesis of results and manuscript organization. A.S.A. drafted the initial manuscript and prepared the figures and tables. All authors reviewed, revised, and approved the final version of the manuscript.

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Competing financial interests

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