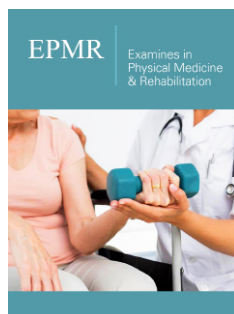


A Comprehensive Narrative Literature Review on the Impact of Kefir on Metabolic Health and Athletes' Overall Well-Being

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Abstract

Background: Kefir, a fermented milk beverage, contains a diverse community of microorganisms that may enhance metabolic health and overall well-being in athletes. Its unique composition, enriched through fermentation, offers bioactive compounds that could influence digestion, immune function, and oxidative stress, which are critical for athletes facing intense training demands.

Materials and Methods: This narrative literature review article systematically analyzed studies from electronic databases, including PubMed, Scopus, and Web of Science, focusing on articles published from 2000 to 2025. The search utilized terms related to kefir, metabolic health, and athletic performance, encompassing both human and animal studies. Inclusion criteria prioritized original research, randomized controlled trials, and observational studies, while review articles provided supplementary context.

Results: The review identified evidence suggesting that kefir positively impacts lipid metabolism, glycemic control, inflammation, and antioxidant capacity. Additionally, it highlights improvements in gut barrier integrity and reductions in exercise-induced gastrointestinal symptoms, supporting the notion that kefir may enhance recovery and performance in athletes.

Conclusion: Kefir presents a promising functional food that may support metabolic health and psychological well-being in athletes through mechanisms such as antioxidant activity and gut-microbiome interactions. However, further empirical research is needed to substantiate these findings and explore practical applications in athletic populations.

Keywords: Kefir; Fermented milk; Athlete' Well-being; Exercise; Metabolic health

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Introduction

Kefir is a fermented milk beverage harboring a complex symbiotic community of lactic acid bacteria, acetic acid bacteria, and yeasts. This unique microbial consortium is responsible for generating a range of biochemical and physiological properties with potential relevance to athlete health. The fermentation process enriches milk with an array of bioactive compounds, including peptides, vitamins, minerals, and microbial metabolites, resulting in a functional food matrix capable of modulating digestion, immune signaling, and redox homeostasis [1,2]. Growing interest in kefir among athletic populations stems from several intersecting factors: the elevated oxidative and inflammatory burden induced by intense training, the heightened nutrient demands for muscle contraction and recovery-including electrolytes,

branched-chain amino acids, and micronutrients-and the emerging understanding of the gut-brain and gut-immune axes in regulating mood and illness susceptibility [3,4]. Kefir's nutritional profile, rich in vitamins, minerals, and protein, alongside its putative role in preventing electrolyte imbalances such as hyponatremia, suggests plausible mechanistic pathways through which it could support athletic performance and metabolic health.

While direct empirical investigation of kefir in human athletes remains limited, the body of evidence is expanding. Findings from randomized controlled trials, mechanistic animal studies, and *in vitro* research converge to indicate that kefir may positively influence lipid metabolism, glycemic control, inflammation, and antioxidant capacity [5,6]. A parallel body of literature on probiotics and fermented dairy products indicates improvements in gut barrier integrity, modulation of systemic cytokines, and a reduction in exercise-induced gastrointestinal symptoms [7-9].

Materials and Methods

This narrative literature review was conducted by systematically searching electronic databases, including PubMed, Scopus, and Web of Science, for relevant articles published between 2000 to 2025. Search terms included combinations of "kefir," "fermented milk," "athlete' well-being," "exercise," "metabolic health." Both human and animal studies were considered. The inclusion criteria encompassed original research articles, randomized controlled trials, and observational studies published in English. Review articles and meta-analyses were consulted for background information and to identify additional primary sources but were not the primary focus of the analysis. After careful consideration, a total of 24 studies were selected for inclusion in this review. The findings were synthesized into thematic areas to provide a comprehensive overview of the current evidence and its implications for athletic populations.

Discussion

The potential benefits of kefir for athletes appear to derive from several discrete yet interrelated biological domains: the modulation of oxidative stress, influence on systemic metabolism (lipids and glucose), maintenance of electrolyte and mineral homeostasis, and psychobiological effects mediated by the gut microbiota. Oxidative stress, characterized by an excess of Reactive Oxygen Species (ROS), increases proportionally with exercise intensity and duration, contributing to muscle fatigue, lipid peroxidation, and delayed recovery [10]. Several studies report that kefir consumption can enhance endogenous antioxidant defenses, such as increasing the activity of superoxide dismutase and glutathione peroxidase, while concurrently reducing markers of lipid peroxidation. This suggests a tangible capacity to mitigate exercise-induced oxidative damage [11].

Metabolic regulation represents another plausible route for kefir's benefits. Clinical trials and observational data indicate that fermented dairy consumption can lead to modest improvements in glycemic control and lipid profiles, mechanisms highly relevant

to athletes managing body composition and energy homeostasis [5,12,13]. Furthermore, kefir's rich content of minerals-including calcium, magnesium, potassium, and sodium-directly supports neuromuscular excitability and fluid balance, which are critical for preventing cramps and hyponatremia during prolonged exertion [14]. The bioavailability of these nutrients is itself influenced by the fermentation process, as probiotics can enhance mineral absorption by modifying gut pH and the metabolic activity of the microbiota [15].

The connection between kefir and psychological well-being emerges from growing research on the gut-brain axis. Microbial metabolites, including short-chain fatty acids and neurotransmitter precursors, alongside immunomodulatory effects, can influence central nervous system processes such as stress reactivity and sleep quality-factors that indirectly impact training adaptation and recovery [16,17]. While kefir-specific trials on mood are limited, several small clinical studies link probiotic intake to reduced anxiety and improved subjective mood scores. Kefir's diverse microbial consortium and production of bioactive peptides position it as a credible candidate for exerting similar psychobiotic effects [18].

A significant challenge in interpreting the kefir literature is the pronounced methodological heterogeneity across studies, including variations in kefir strains, fermentation conditions, dosage, and the fitness levels of participants. Despite this, a mechanistic plausibility is supported by converging evidence from molecular, animal, and human studies: Kefir can modulate redox balance, influence lipid and glucose metabolism, support mineral status, and alter gut-derived signaling relevant to both mood and immunity. Translationally, this suggests kefir could be a valuable functional dietary component for athletes, provided that formulations are standardized and consumption is tailored to individual training demands.

Results

The antioxidant and anti-inflammatory properties of kefir are among the most frequently reported outcomes. Dietary consumption of kefir or kefir fractions consistently results in reductions in markers of oxidative damage and simultaneous improvements in enzymatic antioxidant defenses [19]. In human trials, supplementation with kefir or similar fermented milks over several weeks has led to modest reductions in systemic oxidative markers and, in some studies, favorable alterations in inflammatory cytokines like IL-6 and TNF- α , though these findings are not universal across all study cohorts [5,20]. Kefir consumption tends to be associated with improved metabolic outcomes in both animal models and human interventions. Studies in hypercholesterolemic animals and small-scale human trials have reported that kefir ingestion can lower serum cholesterol and attenuate the oxidation of Low-Density Lipoprotein (LDL) particles [6,13]. Meta-analyses on fermented dairy products more broadly suggest small but clinically meaningful reductions in cardiometabolic risk markers, though kefir-specific meta-analyses are not yet available. Furthermore, kefir's documented mineral and vitamin composition supports its

potential role in maintaining electrolyte balance, a critical concern for athletes, though direct evidence from athlete populations remains scarce.

Modulation of the gut microbiota and related immune outcomes is a promising area, though findings are heterogeneous. *In vitro* and animal studies indicate that kefir can alter microbial community composition, typically increasing the abundance of beneficial taxa like *Lactobacillus* and *Bifidobacterium*, and can reduce pathogen colonization through competitive exclusion and the production of antimicrobial substances [21,22]. Human probiotic research has shown that specific strains can reduce the incidence and duration of upper respiratory tract infections in athletic groups, but extrapolating these results directly to kefir is complicated by its unique and variable microbial composition [9].

While direct evidence is limited, psychophysiological effects are biologically plausible. The broader literature on probiotics and fermented foods indicates they can influence neurotransmitter synthesis (e.g., GABA) and dampen stress responses. A limited number of human trials have demonstrated improved mood and reduced psychological stress markers following probiotic intervention, providing an indirect supportive mechanism for kefir's potential benefits [18,23]. In summary, the available evidence supports the notion that kefir may offer moderate, biologically plausible benefits for metabolic health that could extend to athlete populations, particularly in the contexts of recovery and metabolic resilience. However, heterogeneity in observed effects and a notable absence of large, rigorously designed Randomized Controlled Trials (RCTs) specifically in athletes preclude definitive conclusions.

Limitations

The interpretation of kefir's potential benefits for athletic and metabolic outcomes must be tempered by an acknowledgment of several significant limitations. The most pervasive issue is the considerable experimental heterogeneity across studies. Kefir is not a standardized product; its composition varies widely based on the milk source (e.g., cow, goat, sheep), the type of starter culture used (traditional grains versus commercial blends), fermentation duration, and storage conditions. These variables profoundly alter the microbial ecology, metabolite profile, and nutrient content of the final product [2,21,24], making it difficult to compare results across different studies as they may not be testing equivalent interventions. Many of the available studies are also limited by their preclinical nature or small sample sizes in human trials. These studies often suffer from limited statistical power, short intervention durations, and variable control conditions, which reduces their generalizability to highly trained athletes who possess distinct physiological baselines and substantial energy demands [7].

Inconsistency in outcome measurement further complicates any synthesis of the evidence. Studies employ a wide array of endpoints, ranging from biochemical proxies like oxidative stress markers and cytokines to clinical measures such as glycemic control and cholesterol levels, and subjective reports of mood or

gastrointestinal symptoms. The use of diverse assays, differing sampling times in relation to exercise, and a lack of standardized dosing protocols impede meta-analytic efforts and may introduce spurious heterogeneity [10].

Potential confounding factors and bias present additional concerns. Individual differences in dietary background, previous probiotic exposure, antibiotic history, and baseline gut microbiome composition can all modify an individual's response to kefir, yet few trials control for these variables adequately. Studies involving athletes are particularly susceptible to confounding from training cycle effects, seasonal variations in illness, and potent placebo effects driven by performance expectations. Ethical and logistical challenges often prevent the conduction of large, long-term randomized feeding trials in elite athletes, meaning much of the evidence is derived from recreational athletes or animal models. In order to advance the field, future research must prioritize the use of well-characterized, standardized kefir preparations; conduct adequately powered RCTs in athlete populations; employ rigorous and consistent outcome sets that include functional performance measures; and include mechanistic endpoints that quantify changes.

Conclusion

Synthesis of the current peer-reviewed literature indicates that kefir is a promising functional food for supporting aspects of metabolic health that are relevant to athletic populations. Mechanistically, its antioxidant, anti-inflammatory, and microbiome-modulating properties, combined with its provision of essential micronutrients, offer plausible pathways for enhancing recovery, reducing oxidative damage, and conferring modest metabolic benefits. Although direct evidence from studies on high-performance athletes is limited, related research on probiotics and fermented dairy supports potential advantages for immune function, metabolic regulation, and mood via gut-brain axis communication. Practically, athletes may consider incorporating kefir as a component of a broader nutritional strategy designed to support mineral balance, gut health, well-being and recovery, with attention paid to product consistency and timing of consumption relative to training. Ultimately, a definitive understanding of kefir's role in sports nutrition awaits the execution of robust, athlete-focused randomized controlled trials. These trials should feature standardized kefir formulations, quantified amino acid profiles, and integrated assessments of performance, metabolic biomarkers, and psychological well-being. Until such high-quality data are available, kefir remains a low-risk, nutritionally dense dietary adjunct that is consistent with current evidence linking fermented dairy and probiotics to improved markers of metabolic health.

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