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Literature Review: Fermented Dairy Food Effect on Cardiovascular Biomarker

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Abstract. *Fermented dairy products are functional foods rich in probiotics, bioactive peptides, and nutrients that may provide cardiovascular health benefits. However, evidence regarding their effects on cardiovascular biomarkers remains inconsistent. This study reviewed scientific evidence on the effects of fermented dairy products on cardiovascular biomarkers. A literature review was conducted using national and international publications published between 2020 and 2026. Literature searches were performed through PubMed, Google Scholar, ScienceDirect, SpringerLink, ProQuest, and ResearchGate. Eligible studies were analyzed narratively by summarizing, synthesizing, comparing, contrasting, and critically evaluating their findings. A total of 17 scientific articles met the inclusion criteria and were analyzed. The findings indicate that fermented dairy products, particularly yogurt, kefir, and cheese, may improve cardiovascular biomarkers by reducing total cholesterol and low-density lipoprotein (LDL) levels, increasing high-density lipoprotein (HDL) levels, and decreasing inflammatory biomarkers such as C-reactive protein (CRP). They may also improve glycemic control, modulate gut microbiota by increasing short-chain fatty acid (SCFA)-producing bacteria, and reduce cardiovascular disease risk. However, effects vary according to product type, probiotic composition, dosage, intervention duration, and participant characteristics. Overall, fermented dairy products show potential to support cardiovascular health through improvements in lipid profiles, inflammation, gut microbiota, and glycemic control. Further large-scale clinical trials and well-designed interventions are needed to establish causal relationships and determine optimal consumption strategies.*

Keywords: *Fermented Dairy Products, Probiotics, Cardiovascular Biomarkers, Lipid Profile, Inflammation, Cardiovascular Health*

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INTRODUCTION

Fermented milk products are structurally distinct products obtained through the fermentation of lactose in milk by various microorganisms, primarily lactic acid bacteria (LAB) (Oktay, 2023; Sionek et al., 2023; Sharma et al., 2023; Bintsis & Papademas, 2022). Milk is a food ingredient containing essential nutrients for human life, including protein, fat, carbohydrates, minerals, vitamins, and growth factors. Furthermore, milk serves as a medium for several microorganisms that can alter the chemical composition of milk during storage. Compared with other livestock products, milk is highly perishable, requiring prompt and appropriate handling (Sahala et al., 2024; Zakeri et al., 2018).

Nutritionally, fermented milk products are rich in high-quality animal protein, fat, essential minerals such as calcium and phosphorus, and fat-soluble vitamins (Agyei et al., 2020; Nwadi et al., 2026; Khan et al., 2019; Rajta et al., 2023). The fermentation process adds functional value by producing bioactive peptides and microbial metabolites that can influence lipid and glucose metabolism. Several studies have reported that consuming these products can lower total cholesterol and Low-Density Lipoprotein (LDL), increase High-Density Lipoprotein (HDL), and improve the LDL/HDL ratio, suggesting a potential protective effect on cardiovascular health (Derosa et al., 2020; Stadler & Marsche, 2021; Guasch-Ferré et al., 2023; Velissaridou et al., 2024).

Fermented milk products also contain probiotic bacteria such as Lactobacillus and Bifidobacterium, which play a role in maintaining the balance of the gut microbiota. Align with research from Markowiak-Kopeć & Śliżewska (2020), the presence of these microorganisms can optimize digestion, increase nutrient absorption, and produce bioactive metabolites such as short-chain fatty acids (SCFAs), including butyrate. SCFAs are known to play a role in regulating lipid metabolism, lowering cholesterol and triglycerides, and increasing HDL, thus indirectly contributing to cardiovascular protection (Machlik et al., 2021; Yang et al., 2025).

In addition to their effects on blood lipids, fermented milk products also have the potential to provide anti-inflammatory effects (Kaur et al., 2022; Saleem et al., 2024; García-Burgos et al., 2020; Chen et al., 2023). Studies have shown that consuming yogurt, kefir, or other fermented milk products can lower C-reactive protein (CRP) levels and increase InterFeron-γ (IFN-γ), which are indicators of immune and inflammatory responses. These anti-inflammatory effects tend to be more pronounced in individuals with certain metabolic conditions, such as type 2 diabetes, or in long-term interventions, highlighting the importance of the duration of consumption and the health status of study participants (Machlik et al., 2021).

Furthermore, the effects of fermented dairy products are not limited to lipids and inflammation, but also affect glucose metabolism and other cardiometabolic risk factors (Companys et al., 2021; Lordan et al., 2018). Several meta-analyses have shown that consumption of probiotic fermented milk can reduce fasting blood glucose and HbA1c levels in patients with type 2 diabetes, while yogurt consumption is associated with a reduced risk of type 2 diabetes and metabolic syndrome. This underscores the multifactorial role of fermented dairy products in supporting cardiometabolic health through various physiological pathways (Machlik et al., 2021).

Although evidence suggests the protective potential of fermented dairy products against cardiovascular biomarkers, research results are variable and inconsistent. These differences may be due to variations in product type, probiotic composition, dosage, intervention duration, and study population characteristics. Therefore, systematic and integrative studies are needed to comprehensively understand the relationship between fermented dairy product consumption and cardiovascular biomarkers, as well as to provide a basis for developing safe, effective, and evidence-based functional food strategies.

METHODS

This study employed an observational design with a literature review approach, a secondary research method used to identify, evaluate, and synthesize relevant scientific findings regarding the effect of fermented dairy product consumption on cardiovascular biomarkers. This approach was chosen because it provides a comprehensive overview of available scientific evidence and identifies consistent patterns of findings and any remaining research gaps. The data sources used were secondary data obtained from national and international scientific publications, including original research articles, review articles, theses, textbooks, and full-text e-books. A systematic literature search was conducted through PubMed, Google Scholar, ScienceDirect, SpringerLink, ProQuest, and ResearchGate, covering the publication years 2020–2026. This period was selected to obtain the most up-to-date and relevant scientific evidence regarding the role of fermented dairy products in cardiovascular health. The literature search strategy used a combination of keywords in Indonesian and English, including "fermented dairy," "probiotic dairy products," "cardiovascular biomarkers," "lipid profile," "blood pressure," and

"heart health." The selection process was carried out in stages through screening of titles, abstracts, and a full-text review to assess topic suitability, methodological quality, and data completeness. Articles that met the inclusion criteria were then analyzed using a narrative approach through summarizing, synthesizing, comparing, contrasting, and critiquing stages to produce critical, evidence-based interpretations. The variables analyzed included fermented milk product consumption as the independent variable, and cardiovascular biomarkers as the dependent variables, including blood lipid profiles, blood pressure, and inflammatory biomarkers. Data were analyzed based on biomarker changes reported in each study, taking into account the type of fermented milk product, subject characteristics, study design, intervention duration, and the level of evidence of each study.

RESULT AND DISCUSSION

This research employed a literature review method, an approach that involved exploring various scientific sources through scholarly searches related to the topic "Literature Review: The Effect of Fermented Milk Products on Cardiovascular Biomarkers." This method was chosen because it provides a comprehensive overview of previous research while demonstrating consistent findings. In its implementation, the researchers not only collected information but also analyzed a variety of published literature. Prior to the review process, the literature was selected following a predetermined process and criteria. After the screening process, 17 pieces of literature relevant to the research topic were identified and used as reference sources. Each piece of literature was reviewed in depth, summarized, and then presented in tabular form for analysis and conclusion drawing.

Table 1. Journal Article Description

(Author) (Country)	Purpose	Methods	Result
Birsen Yilmaz, Panagiota Alvanoudi, Aggeliki Kalogeropoulou, Dushica Santa, Tuğçe Bulmuş-Tüccar, Anastasios Nikolaou, Isabel Moreno-Indias, Patricia Ruiz-Limon, Carolina Gutiérrez-Repiso, Elaine Hillesheim, Victoria Meslier, Baltasar Mayo, Jeadran Malagon, Christophe Chassard, Smilja Praćer, Guy Vergeres and Fani Th Mantzouridou (2025) (Europe, multicenter)	To assess the association between consumption of conventional fermented milk products with blood lipid levels and cardiovascular disease in healthy adults.	Systematic review: 68 studies (14 controlled interventions, 37 non-controlled interventions, 17 observational studies) were analyzed narratively following EFSA guidelines. Focus was on bioactive compounds, mechanisms of action, and safety.	The majority of intervention studies show no significant changes in blood lipids. Some studies show reductions in total cholesterol and LDL-C, or improvements in the LDL/HDL ratio, particularly with yogurt and kefir. Observational results are mixed and inconsistent. Study quality and mechanistic evidence are less convincing, requiring better controlled human studies.
Elaheh Rashidbeygi, Mahnoush Mehrzad Samarin, Fatemeh Sheikhhossein, Amir Hossein	To assess the effect of kefir (fermented milk drink) consumption on blood pressure and CRP in adults.	Systematic review and meta-analysis of RCTs (up to January 2025); 7 studies, total 385 adult	There was no significant effect on systolic (WMD −1.76 mmHg) or diastolic

Khalilkhaneh, Masoomeh Gholizadeh, Negin Lohrasbi, Amin Abbasi, Hadi Bazyar, Gholamreza Askari, Mohammad Reza Amini (2025) (Iran)		subjects. Analysis using a random-effects model, WMD 95% CI.	(WMD −1.19 mmHg) blood pressure. CRP did not decrease significantly overall (WMD −0.17 mg/L). Subgroup analysis showed a significant decrease in CRP with consumption lasting ≥8 weeks. Conclusion: Long-term kefir (fermented milk drink) consumption may reduce inflammation, but the effect on blood pressure is not significant.
Nanny Djaya, Christina Jeanny Soekiono, Irene Vanessa (2025) (Indonesia)	Examining the effects of omega-3 fatty acids, specifically EPA and DHA, on post-cardiovascular procedure recovery and their impact on reducing inflammation, regulating blood pressure, pain management, and improving lipid profiles.	A literature review exploring the benefits of omega-3 fatty acids on cardiovascular recovery, particularly in the context of cardiovascular procedures.	Triglyceride reduction: Omega-3 fatty acids have shown significant effects in lowering triglyceride levels, a major risk factor for heart disease. Blood pressure regulation: Omega-3 fatty acids contribute to lowering blood pressure in patients with hypertension. Inflammation reduction and pain management: Inflammation reduction and pain management have been shown, including in neuropathic and inflammatory pain. Arrhythmia prevention: Omega-3s have shown potential in preventing post-procedural cardiac arrhythmias. Although these findings are promising, dosage, formulation, and long-term effects still

			require further research to determine its optimal use in clinical practice.
A Sahra Salsabilla, Asrini Safitri, Irmayanti Haidir Bima (2025) (Indonesia)	To assess the effect of fermented milk product consumption on lipid profiles in obese individuals.	A systematic literature review examining scientific articles from PubMed, NCBI, Google Scholar, and Web of Science (2015–2025).	Fermented milk products such as curd, dangke, kefir, yogurt, and synbiotics are associated with improvements in total cholesterol, LDL, and triglyceride levels. Increased HDL in some study groups. Mechanisms involving lactic acid bacteria in cholesterol assimilation, increased bile acid excretion, and modification of intestinal microbiota. Further clinical research is needed to determine the optimal dose and long-term effectiveness.
Laksmi Nur Fajriani, Ni Made Wiasty Sukanty, Anisah, Widani Darma Isasih, Nissa Anggriany, Siti Ulfatun Najiyyah (2025) (Indonesia)	Reviewing the effect of fermented milk products on the risk of cardiovascular disease (CVD).	The literature review used the PRISMA method with a descriptive approach. The process included identification, screening, eligibility, and inclusion, with a total of 14 articles analyzed.	Fermented milk products contain probiotics (Lactobacillus, Bifidobacterium) and bioactive compounds. Can lower LDL and increase HDL through HMG-CoA reductase inhibition and increased bile acid excretion. Contributes to lowering blood pressure and systemic inflammation. High consumption of fermented milk products can reduce the risk of CVD by up to 19%.

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			Potential as a cardiovascular disease prevention strategy.
Hao Zhong, Lingmiao Wang, Fuhuai Jia, Yongqiu Yan, Feifei Xiong, Khemayanto Hidayat, Yunhong Li (2024) (China)	To assess the effects of probiotic fermented milk supplementation on glucose metabolism, lipids, and inflammatory biomarkers in type 2 diabetes (T2DM) patients.	Meta-analysis of RCTs: PubMed, Web of Science, Cochrane Library; 7 studies included T2DM patients. The analysis used a random-effects model to calculate the weighted mean difference (WMD) and 95% CI.	Supplementation reduced fasting plasma glucose (MD = −17.01 mg/dL) and HbA1c (MD = −0.47%). Reduced total cholesterol (MD = −5.15 mg/dL) and CRP (MD = −0.25). No significant effect on HOMA-IR, triglycerides, LDL-C, HDL-C, and TNF-α. Shows potential benefits on glucose, lipid metabolism, and inflammation, but more robust evidence is needed to determine clinical significance.
Giorgia La Barbera, Giulia Praticò, Lars Ove Dragsted, Catalina Cuparencu (2024) (Denmark / Italia)	Identify metabolic biomarkers that differentiate fermented dairy product and red meat consumption, and validate associated dietary biomarkers (BFIs).	A randomized, controlled, cross-over, single-meal study was conducted on 17 subjects. A meal containing yogurt/fermented cheese was compared with meatballs. Postprandial urine was collected for up to 24 hours and analyzed using UHPLC-qTOF metabolomics. Data were analyzed using repeated measures ANOVA, PLSDA, and ML-PLSDA.	Confirming milk metabolic biomarkers such as acylglycines and proline-based dipeptides. Discovering new biomarkers for dairy intake. Microbial metabolites show only marginal differences between the two protein types. These results support more accurate assessment of dairy intake in future dietary studies.
Songul Catik Yildiz, Cemil Demir, Mustafa Cengiz, Halit Irmak, Betul Peker Cengiz, and Adnan Ayhanci. (2024) (Türkiye)	To evaluate the protective effect of fermented kefir against cardiac and liver toxicity induced by cyclophosphamide (CPx) in rats, by	The experimental design involved 42 male albino Wistar rats. Kefir was administered orally for 12 days at doses of 5 and 10 mg/kg,	CPx causes an increase in biomarkers of heart damage, namely AST, CK-MB, IMA, and Troponin I.

	assessing changes in biochemical biomarkers and tissue histopathology.	while cyclophosphamide was administered intraperitoneally on the 12th day at a dose of 150 mg/kg. Parameters analyzed included biomarkers of liver and heart damage and histopathological examination of the tissue.	An increase in AST indicates tissue damage, including heart tissue, due to CPx toxicity. An increase in CK-MB and Troponin I indicates injury or damage to heart muscle cells. An increase in IMA indicates oxidative stress and ischemia in heart tissue. Fermented kefir administration reduced AST, CK-MB, IMA, and Troponin I levels compared to the CPx group, thus demonstrating a cardioprotective effect. A 10 mg/kg kefir dose provided a better protective effect than a 5 mg/kg dose. Overall, the results of the study indicate that fermented kefir may help protect heart tissue from CPx toxicity by reducing oxidative stress and myocardial cell damage.
Miguel A. Rendon-Rosales, José I. Méndez-Romero, Adrián Hernández-Mendoza, Aarón F. González-Córdova, Miguel A. Mazorra-Manzano, Hugo S. García, Lilia M. Beltrán-Barrientos, María C. Estrada-Montoya, Belinda Vallejo-Cordoba (2024) (Meksiko)	Evaluating the relationship between gut microbiota and the hypocholesterolemic effect of fermented milk with Lactococcus lactis strain.	In vivo experiments in hypercholesterolemic Sprague–Dawley rats for 7 weeks. Microbiota analysis using 16S rRNA sequencing and SCFA (short-chain fatty acid) measurements.	A high-cholesterol diet causes gut microbiota dysbiosis. Fermented milk improves microbiota composition, particularly increasing butyrate-producing bacteria. Butyrate correlates negatively with total cholesterol and LDL, and positively with HDL. Bacteria such as Ruminococcaceae and Lactobacillaceae

			increase after the intervention. The cholesterol-lowering effect occurs through modulation of gut microbiota and lipid metabolism.
Karl Michaëlsson, Eva Warensjö Lemming, Susanna C. Larsson, Jonas Höijer, Håkan Melhus, Bodil Svennblad, John A. Baron, Alicja Wolk, Liisa Byberg (2024) (Sweden)	To assess the association of fermented and non-fermented milk consumption with the risk of ischemic heart disease (IHD) and cardiometabolic biomarkers in plasma.	A prospective longitudinal cohort study of 100,775 participants with up to 33 years of follow-up. Analysis using Cox regression and measurement of 276 cardiometabolic plasma proteins.	High consumption of non-fermented milk in women increases the risk of coronary heart disease and myocardial infarction. Fermented milk is not significantly associated with an increased risk of coronary heart disease or MI. Consumption of non-fermented milk increases biomarkers such as ACE2 and decreases FGF21. No significant negative effects of fermented milk on cardiovascular biomarkers were found. Shows that the type of dairy product (fermented vs. non-fermented) influences cardiovascular risk.
Xiaofeng Zhang, Qiuping Luo, Xiaoxian Guan, Xiaoli Chen, Jinlan Deng, Jianming Fan (2023) (China)	Exploring the effects of fermented dairy products (FDPs) on inflammatory biomarkers.	Meta-analysis of 14 trials (15 arms): yogurt (n=9), fermented milk (n=4), kefir (n=2). A random/fixed effects model was used to analyze the effects on CRP, IFN-γ, TNF-α, IL-2, IL-6, IL-10.	FDPs decreased CRP (SMD = −0.21; 95% CI: −0.40, −0.02) and increased IFN-γ (SMD = 0.12; 95% CI: 0.01, 0.23). Significant effects on CRP were observed, especially in participants with metabolic disease. IFN-γ increased in interventions of ≥12 weeks, yogurt, healthy populations, and Asian populations.

			No significant effects on TNF-α, IL-2, IL-6, or IL-10. The results showed that FDP consumption was slightly associated with reduced inflammation.
Verrina Amira Harjo, Tetty Herta Doloksaribu (2023) (Indonesia)	To determine the effect of fermented food consumption on blood lipid profiles.	Literature study involving searches on Google Scholar, GARUDA Portal, DOAJ, and PubMed using the keywords "fermented food" and "blood lipid profile."	Of the 10 eligible articles, 8 showed a significant effect of fermented food consumption on blood lipid profiles. Effective fermented foods include tempeh, synbiotic banana yogurt, kefir, feta cheese, and black sticky rice tape. Chungkukjang and cinnamon synbiotic yogurt did not show significant improvement.
Luh Putu Laksmi Wiryani, Putu Sanna Yustiantara (2023) (Indonesia)	To assess the potential of oat milk as a plant-based milk alternative for patients with hypercholesterolemia in lowering LDL cholesterol levels.	A literature study that examines national and international research articles and reviews, especially in the last five years, that discuss the effects of oat beta-glucan on reducing cholesterol levels.	Consuming oat beta-glucan three times daily for four weeks resulted in a 6% reduction in LDL cholesterol levels, although there was no change in HDL cholesterol and triglycerides. Oat beta-glucan modulates gut microbial fermentation in cholesterol metabolism, influencing the production of short-chain fatty acids, which contribute to lowering LDL cholesterol. Oat milk can be recommended as an alternative to pure milk for people with hypercholesterolemia

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			with the benefit of reducing LDL cholesterol levels.
Kathy Trieu, Saiuj Bhat, Zhaoli Dai, Karin Leander, Bruna Gigante, Frank Qian, Andres V. Ardisson Korat, Qi Sun, Xiong-Fei Pan, Federica Laguzzi, Tommy Cederholm, Ulf de Faire, Mai-Lis Hellénius, Jason H. Y. Wu, Ulf Risérus, Matti Marklund (2021) (Swedia & internasional/*Meta-analysis*)	To examine the relationship of milk fat biomarkers (especially pentadecanoic acid/15:0) with the incidence of cardiovascular disease (CVD) and all-cause mortality.	A prospective cohort study of 4,150 Swedish adults (median follow-up 16.6 years) with serum biomarker measurements (15:0). This was followed by a systematic review and meta-analysis of 18 observational studies assessing milk fat biomarkers (15:0, 17:0, t16:1n-7) on CVD risk and mortality.	Higher 15:0 levels were associated with a reduced risk of CVD (HR 0.75; 95% CI 0.61–0.93). Milk fat biomarkers (15:0 and 17:0) showed an inverse association with CVD risk in a meta-analysis. No significant association was found between these biomarkers and all-cause mortality. The biomarkers cannot differentiate between the type of dairy product (fermented vs. non-fermented), thus limiting interpretation. The results support a potential protective effect of dairy on cardiovascular health, but further experimental studies are needed to confirm causality.
Bayu Kanetro, Agus Slamet, Cahyo Budiyanto (2021) (Indonesia)	To determine the effect of adding 3% jack bean seed isolate or sprouts on cholesterol levels and fatty acid profiles in cow's milk.	Completely randomized design with three treatments: pure cow's milk without addition (K0), milk with 3% sword bean seed isolate (K1), and milk with 3% sword bean sprout isolate (K2).	Adding 3% sword bean seed or sprout isolate significantly reduced the cholesterol content of cow's milk. The fatty acid profile of milk supplemented with sword bean sprout or seed isolate was better, with lower levels of saturated fatty acids and higher levels of unsaturated fatty acids. The greatest reduction in

			cholesterol levels occurred in milk supplemented with 3% sword bean sprout isolate. To conclude the potential of sword bean isolate as a functional drink for the prevention of cardiovascular disease.
Judit Companys, Laura Pla-Pagà, Lorena Calderón-Pérez, Elisabet Llauradó, Rosa Solà, Anna Pedret, Rosa M Valls (2020) (Spanyol)	To evaluate the relationship between fermented milk product consumption and probiotic supplementation and the risk of cardiometabolic disease (CMD).	Systematic review & meta-analysis: 20 prospective cohort studies (PCSs) and 52 RCTs. Analysis of the risk of stroke, ischemic heart disease, type 2 diabetes, metabolic syndrome, and lipid and anthropometric biomarkers.	Fermented milk is associated with a 4% reduced risk of stroke, ischemic heart disease, and cardiovascular death. Yogurt reduces the risk of T2D by 27% and metabolic syndrome by 20%. Probiotics in dairy matrices are more effective in lowering lipids in hypercholesterolemic subjects; in capsules/powders they are more effective in T2D. Both supplementation methods reduce anthropometric parameters in obesity. Conclusion: fermented milk consumption reduces cardiovascular risk, but study heterogeneity and differences in probiotic strains need to be considered.
Behnaz Pourrajab, Nasim Naderi, Leila Janani, Vahid Mofid, Marjan Hajahmadi, Afsaneh Dehnad, dan Farzad Shidfar. (2020)	To compare the effects of probiotic and regular yogurt consumption on serum Pentraxin-3 and NT-proBNP levels in patients	A 10-week, triple-blind, randomized controlled clinical trial in patients with chronic heart failure (CHF). Participants were divided into	Consuming probiotic yogurt for 10 weeks reduced PTX3 levels in both the probiotic and regular yogurt groups.

(Iran, Tehran)	with chronic heart failure.	two groups: one consuming 300 mL/day of probiotic yogurt and one consuming 300 mL/day of regular yogurt. Biomarkers measured before and after the intervention included PTX3 and NT-proBNP.	However, the decrease in PTX3 in the probiotic yogurt group was not significantly different from that in the regular yogurt group. NT-proBNP levels showed no significant changes after consuming probiotic yogurt compared to regular yogurt. Overall, probiotic yogurt has not shown any significant effect on the inflammatory biomarker PTX3 or the cardiac stress biomarker NT-proBNP in chronic heart failure (CHF) patients.

Fermented dairy products have long been a staple in traditional diets and are now receiving increasing scientific attention. Numerous studies have shown that these products are not only valuable as a nutritious food source but also have significant health potential. Fermented dairy products are rich in probiotics, bioactive compounds, and microbiological activity that contribute to improvements in cardiovascular biomarkers, particularly lipid profiles, blood pressure, and inflammation.

Effect on Lipid Profile

Fermented dairy products are known to have the potential to improve blood lipid profiles, although available research results show considerable variation. In general, products such as yogurt, kefir, and fermented milk contain probiotics and bioactive compounds from fermentation that are thought to play a role in lipid metabolism. Research by Salsabilla et al. (2025) shows that most intervention studies do not find significant changes in blood lipid parameters, such as total cholesterol, LDL, and HDL, although there are several reports showing reductions in total and LDL cholesterol, as well as improvements in the LDL/HDL ratio, particularly with the consumption of yogurt and kefir over a period of time. Harjo and Doloksaribu (2023) also states that the consumption of fermented milk products is consistently associated with reduced lipid levels, and that the food matrix of fermented milk products may provide a synergistic effect between probiotics and other nutritional components in modulating lipid metabolism. Furthermore, Kanetro et al. (2021) reports that the addition of sword bean seed isolate or sprouts to cow's milk can significantly lower cholesterol levels. This confirms the potential of fermented milk products as part of a strategy for better lipid profile management.

Research by Yilmaz et al. (2025) shows that most intervention studies do not find significant changes in blood lipid parameters, such as total cholesterol, LDL, and HDL. However, several studies in the analysis reported reductions in total and LDL cholesterol and improvements in the LDL/HDL ratio, particularly with prolonged consumption of yogurt and kefir. This variation in results is likely influenced by differences in study design, subject characteristics, product type, and duration of intervention.

Consistent with these findings, Zhong et al. (2024) in a meta-analysis of controlled clinical trials reported that probiotic fermented milk supplementation significantly reduced total cholesterol levels. However, the effects on other lipid fractions, such as LDL and HDL, did not show statistically significant changes. This indicates that the effect of fermented milk products on lipid profiles may be selective or require specific conditions, such as longer consumption duration, adequate dosage, or populations with metabolic disorders such as type 2 diabetes.

Furthermore, Companys et al. (2020) stated that the consumption of fermented milk products is consistently associated with a reduced risk of cardiovascular disease, mediated in part through improvements in lipid biomarkers. Probiotic-enriched fermented milk products were reported to be more effective in lowering lipid levels in individuals with hypercholesterolemia than other forms of supplementation, such as capsules or powders. This suggests that the food matrix of fermented milk products can provide a synergistic effect between probiotics and other nutritional components in modulating lipid metabolism.

Furthermore, research by Rendon-Rosales et al. (2024) provides a mechanistic explanation for the hypocholesterolemic effects of fermented milk products. The study showed that consuming fermented milk can increase the production of short-chain fatty acids (SCFAs), particularly butyrate, through modulation of the gut microbiota. Butyrate is known to play an important role in lipid metabolism by inhibiting cholesterol synthesis in the liver, increasing bile acid excretion, and improving blood lipid balance. Furthermore, increasing the abundance of SCFA-producing bacteria such as Lactobacillaceae and Ruminococcaceae also contributes to lowering total and LDL cholesterol levels and increasing HDL.

Effect on Inflammatory Biomarkers

Inflammation is a major factor in the pathogenesis of cardiovascular disease, as it plays a role in atherosclerosis and blood vessel damage. In this regard, Zhang et al. (2023) demonstrated that consuming fermented milk products can have anti-inflammatory effects, as indicated by reduced C-reactive protein (CRP) levels and increased interferon-gamma (IFN-γ) levels. These findings indicate that fermented milk products have the potential to reduce systemic inflammation associated with cardiovascular disease risk.

However, not all studies have shown consistent results. Rashidbeygi et al. (2025) reported that kefir consumption had no significant effect on overall CRP levels. However, subgroup analysis in this study showed a significant reduction in CRP with long-term consumption, i.e., for ≥8 weeks. This suggests that the duration of the intervention may be an important factor in determining the effectiveness of fermented milk products on inflammatory biomarkers.

Additionally, Zhong et al. (2024) also found a decrease in CRP levels in type 2 diabetes patients after probiotic fermented milk supplementation. These results suggest that the anti-inflammatory effects of fermented milk products tend to be more pronounced in individuals with certain metabolic conditions. Therefore, it can be concluded that the benefits of fermented milk products on inflammation are influenced by the duration of consumption and subject characteristics, so further research is needed to confirm these effects more consistently.

Effect on Glucose Metabolism and Cardiometabolism

Fermented milk products also play a role in regulating glucose metabolism and various other cardiometabolic risk factors. Zhong et al. (2024) showed that consuming probiotic fermented milk can reduce fasting blood glucose and HbA1c levels in type 2 diabetes patients. These findings indicate that fermented milk products have the potential to improve glycemic control, which is an important factor in preventing cardiovascular complications. Wiryani and Yustiantara (2023) added that oat milk, as a plant-based milk, can contribute to lowering LDL cholesterol levels in individuals with hypercholesterolemia.

Additionally, Companys et al. (2020) reported that yogurt consumption is associated with a reduced risk of type 2 diabetes and metabolic syndrome. This suggests that fermented dairy

products play a role not only in disease management but also in the prevention of metabolic disorders. The probiotic and bioactive compounds in these products are thought to contribute to increased insulin sensitivity and improved energy metabolism.

Furthermore, Michaëlsson et al. (2024) found that high consumption of non-fermented milk was associated with an increased risk of ischemic heart disease in women, while consumption of fermented milk showed no significant negative effect on this risk. These findings suggest that the type of dairy product consumed plays a significant role in cardiometabolic health, with fermented milk products tending to be safer and potentially beneficial than non-fermented products.

In addition to its role in regulating glucose metabolism, fermented milk products may also affect cardiometabolic risk by reducing oxidative stress. A study by Cetik Yildiz et al. (2024) demonstrated that kefir has a significant protective effect against oxidative stress-induced damage. In rats given cyclophosphamide, there was an increase in biomarkers of heart and liver damage, such as AST, CK-MB, IMA, and Troponin I. Kefir administration, particularly at a dose of 10 mg/kg, significantly reduced these biomarkers and improved histopathological damage to heart and liver tissue. The mechanism is thought to involve a reduction in reactive oxygen species (ROS), inhibition of lipid peroxidation, and increased cellular antioxidant defenses. However, this study is limited by its use of an animal model and the failure to comprehensively measure lipid profiles, gut microbiota, or inflammatory biomarkers.

Furthermore, Pourrajab et al. (2020) showed that consuming probiotic yogurt for 10 weeks in patients with chronic heart failure (CHF) significantly reduced oxLDL levels compared to regular yogurt, indicating a reduction in lipid oxidation. The mechanism is thought to involve strengthening the intestinal barrier, reducing lipopolysaccharide (LPS), inhibiting the Toll-like receptor (TLR) pathway, and increasing antioxidant activity. However, PTX3 and NT-proBNP levels did not change significantly, suggesting that the primary effect of probiotic yogurt in this study is more related to improvements in oxidative stress than inflammation or cardiac stress. A limitation of this study is that it did not measure gut microbiota composition, SCFAs, TMAO, or gene expression related to inflammation and oxidative stress, so the biological mechanism cannot be directly determined.

Fermented milk products have the potential to be an effective dietary intervention in reducing the risk of cardiovascular disease through gut microbiota modulation, lipid profile improvement, decreased inflammatory biomarkers, and improved glycemic control. Longer consumption duration and appropriate dosage can maximize the benefits.

The Role of Gut Microbiota and Metabolic Biomarkers

One of the key mechanisms underlying the benefits of fermented milk products on cardiovascular health is their ability to modulate the gut microbiota. Rendon-Rosales et al. (2024) showed that fermented milk consumption can increase the population of SCFA-producing bacteria, especially butyrate, such as Ruminococcaceae and Lactobacillaceae. This increase in bacteria plays a crucial role in improving the balance of the gut microbiota, ultimately contributing to lower total and LDL cholesterol levels and increased HDL. Thus, modulation of the gut microbiota is an important pathway in the hypocholesterolemic effects of fermented milk products.

Furthermore, a metabolomics approach provides a deeper understanding of the relationship between fermented milk product consumption and the body's metabolic responses. La Barbera et al. (2024) successfully identified specific metabolic biomarkers from the consumption of fermented dairy products, such as acyl-glycines and proline-based dipeptides. These biomarkers can be used to more objectively assess dietary intake and understand how the body responds to the bioactive components of fermented dairy products. These findings also open up opportunities for the development of more accurate dietary evaluation methods in nutrition and cardiovascular research.

Changes in gut microbiota composition and the resulting metabolites suggest that the effects of fermented dairy products are not solely direct through their nutritional content but also involve complex interactions between diet, the microbiome, and the body's metabolic systems. These interactions can influence various biological pathways, including lipid metabolism, inflammation regulation, and immune function. Therefore, understanding the role of the gut microbiota is key to elucidating the mechanisms by which fermented dairy products improve overall cardiovascular health.

Association with Cardiovascular Disease Risk

Several studies have shown a positive association between the consumption of fermented dairy products and a reduced risk of cardiovascular disease, although the underlying mechanisms remain to be explored. Fajriani et al. (2025) reported that high consumption of fermented dairy products, including yogurt, kefir, and cheese, can reduce the risk of cardiovascular disease by up to 19%. This reduced risk is thought to be related to the content of probiotics such as Lactobacillus and Bifidobacterium and the bioactive compounds produced during fermentation, which play a role in lowering LDL levels, increasing HDL, and reducing blood pressure and systemic inflammation. These findings confirm the potential of fermented dairy products as part of a cardiovascular disease prevention strategy through nutritional and microbial mechanisms.

Furthermore, evidence from population studies and meta-analyses supports the protective effects of fermented milk against various specific cardiovascular diseases. Companys et al. (2020) found that fermented milk consumption is associated with a reduced risk of stroke and ischemic heart disease, while Trieu et al. (2021) reported that milk fat biomarkers, such as pentadecanoic acid and heptadecanoic acid, are associated with a reduced risk of cardiovascular events. These biomarkers suggest a correlation between dairy product consumption, particularly fermented products, and a healthier lipid profile, as well as potential protective effects on overall cardiovascular health.

In the context of cardiovascular disease risk, fermented dairy products such as kefir and probiotic yogurt have the potential to provide benefits by reducing oxidative stress and lipid oxidation. Cetik et al. (2024) showed that kefir significantly reduced biomarkers of heart and liver damage in a rat model, while Pourrajab et al. (2020) reported that probiotic yogurt reduced oxLDL levels in patients with chronic heart failure (CHF). The primary mechanisms are thought to be a reduction in reactive oxygen species (ROS), inhibition of lipid peroxidation, strengthening the intestinal barrier, reducing LPS, and increasing antioxidant activity. However, both studies remain limited because the biological mechanisms have not been directly demonstrated through more comprehensive measurements of gut microbiota, complete lipid profiles, SCFAs, TMAO, and inflammatory biomarkers.

Nevertheless, several researchers emphasize that the current evidence is still not entirely consistent or strong enough to conclude a causal relationship between fermented milk product consumption and reduced cardiovascular risk. Yilmaz et al. (2025) highlighted the limitations of most studies, including heterogeneity in study design, varying sample sizes, short intervention durations, and differences in the types and amounts of fermented products consumed. Therefore, further studies with more rigorous designs, controlled interventions, and in-depth mechanistic analyses are needed to confirm the protective effects of fermented milk on cardiovascular disease and understand the biological pathways involved.

CONCLUSION

Based on the results of the research conducted, it can be concluded that; (1) Fermented milk products, such as yogurt, kefir, and cheese, contain probiotics (Lactobacillus, Bifidobacterium) and bioactive compounds that play a role in improving cardiovascular health by modulating blood lipids, blood pressure, and inflammation. Consumption of these products has been shown to lower LDL, increase HDL, and reduce the risk of cardiovascular disease by up to 19% in certain populations; (2) The protective effect of fermented milk against cardiovascular

disease is also associated with modulation of the gut microbiota, including an increase in butyrate-producing bacteria (Ruminococcaceae, Lactobacillaceae), which contribute to lipid metabolism and improve blood lipid profiles; (3) Fermented milk products exhibit anti-inflammatory effects, especially with long-term consumption or in certain metabolic conditions, such as patients with type 2 diabetes, through a decrease in inflammatory biomarkers such as C-reactive protein and an increase in IFN-γ; (4) Consumption of fermented milk is also associated with a reduced risk of cardiometabolic diseases, including type 2 diabetes and metabolic syndrome, and is considered safer than consumption of non-fermented milk in a cardiometabolic context; (5) Although evidence suggests protective potential, research results are still variable and not strong enough to definitively conclude a causal relationship, so better controlled intervention studies with large sample sizes, long intervention durations, and in-depth mechanistic analyses are needed.

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