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Literature Review: The Effect of Fermented Food Consumption (Kombucha, Kimchi, Yogurt) on Antioxidant Status and Gastric Tract Health

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Abstract. *Gut health and redox balance play an important role in the prevention of various chronic diseases associated with oxidative stress and gut microbiota dysbiosis. The consumption of fermented foods such as kombucha, kimchi, and yogurt has gained increasing attention due to their potential benefits in improving antioxidant status and gastrointestinal health. This study aimed to review the effects of kombucha, kimchi, and yogurt consumption on antioxidant status and gut health. This study was conducted as a literature review using a systematic narrative review approach. Article searches were performed through PubMed/MEDLINE, ScienceDirect, the Directory of Open Access Journals (DOAJ), and Google Scholar. Included articles were published within the last ten years, available in full text, and relevant to the research topic. Article selection involved duplicate removal, title and abstract screening, and full-text assessment based on predefined inclusion and exclusion criteria. The synthesis results indicate that fermented food consumption is consistently associated with increased antioxidant capacity, reduced oxidative stress markers, and improved gut health through modulation of gut microbiota and increased production of fermentation-derived metabolites. Kombucha, kimchi, and yogurt exhibit complementary benefits in supporting microbiota balance and antioxidant status. In conclusion, the consumption of fermented foods has the potential to serve as a safe functional dietary intervention to support gut health and antioxidant balance.*

Keywords: *Antioxidant Status, Fermented Foods, Gut Health, Kimchi, Kombucha, Yogurt*

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INTRODUCTION

Gastrointestinal health and the body's redox balance are key components in preventing various chronic diseases and metabolic disorders (Vona et al., 2021; McBeth et al., 2025; Mostafavi et al., 2024). Oxidative stress, resulting from an imbalance between free radicals and the antioxidant system, has been linked to an increased risk of degenerative diseases such as obesity, type 2 diabetes, and inflammatory bowel disorders. Therefore, dietary strategies that can increase antioxidant status while improving gut microbiota health have become an important focus in modern nutrition research. One approach that is gaining attention is the consumption of fermented foods as part of a functional diet that supports both aspects simultaneously (Hananta et al., 2025)

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Fermented foods, including kombucha, kimchi, and yogurt, are produced through the activity of microorganisms that produce bioactive metabolites such as organic acids, peptides, and phenolic compounds (Park & Mannaa, 2025; Shah et al., 2023; Anumudu et al., 2024; Künili et al., 2025; Gustaw et al., 2021; Senthilkumar & Muthiah, 2026). This fermentation process not only improves the nutritional profile of foods but also increases the content of antioxidant and probiotic compounds that can contribute to gut microbiota balance and immune function. Kombucha, for example, has demonstrated significant antioxidant capacity due to the increase in phenolic compounds during the fermentation of sweet tea with symbiotic bacterial and yeast cultures (Nisak, 2023; Antolak et al., 2021; Jakubczyk et al., 2023; Logeshwari & Adeyeye, 2025; Anshory et al., 2026; Guo et al., 2024)

Besides kombucha, kimchi is a traditional fermented vegetable food rich in probiotics and phytochemicals (Dimidi et al., 2019; Ampemohotti et al., 2025; Sahoo et al., 2023). Research shows that kimchi consumption can modulate the composition of the gut microbiota and reduce the presence of pathogenic bacteria while increasing the population of beneficial bacteria. Several clinical studies have also reported that kimchi consumption is associated with positive changes in blood lipid profiles and microbiota composition, which have implications for improved digestive health and a reduced risk of obesity (Lee et al., 2024)

Of the fermented dairy products, yogurt has long been recognized as a source of probiotics that support gastrointestinal health and the immune system. Starter microorganisms such as Lactobacillus bulgaricus and Streptococcus thermophilus play a role in milk fermentation, which not only improves lactose tolerance but also provides a bacterial colony capable of interacting with the gut microbiota (Stachelska et al., 2024; Abdul et al., 2023). Various systematic studies have shown that yogurt consumption is associated with improved gut function, modulation of the immune response, and an indirect increase in antioxidant status through reduced systemic oxidative stress (Hadjimbei et al., 2022)

The mechanisms behind the health effects of fermented foods such as kombucha, kimchi, and yogurt are thought to involve complex interactions between probiotics, bioactive compounds, and the host immune response. Probiotics from these foods can increase the production of short-chain fatty acids (SCFAs), which support intestinal epithelial integrity, reduce inflammation, and inhibit the growth of pathogenic microorganisms. Meanwhile, polyphenolic compounds and fermented metabolites are believed to provide additional antioxidant effects that help neutralize free radicals in body tissues (Gao et al., 2025)

Although scientific evidence regarding the health benefits of fermented foods is growing, there is variation in the quality of the evidence and reported study results. Some studies are still limited to in vitro or animal models, while human clinical trials have shown mixed results regarding dosage, duration of consumption, and individual responses. This gap emphasizes the need for a systematic literature review that combines findings from various studies to comprehensively summarize the effects of kombucha, kimchi, and yogurt consumption on antioxidant status and gastrointestinal health (Wei et al., 2025)

With this background, this literature review aims to synthesize the latest scientific evidence regarding the association between fermented food consumption, particularly kombucha, kimchi, and yogurt, and changes in antioxidant status and their impact on gastrointestinal health. This research is expected to provide a clear picture of the mechanisms of action of probiotics and fermented metabolites, as well as open up further research directions in the development of fermented food-based dietary interventions for improving public health.

METHODS

This study is a literature review with a systematic narrative review approach that aims to examine the effect of fermented food consumption, specifically kombucha, kimchi, and yogurt, on antioxidant status and gastrointestinal health. Article searches were conducted systematically through the scientific databases PubMed/MEDLINE, ScienceDirect, Directory of Open Access

Journals (DOAJ), and additional searches through Google Scholar, using a combination of keywords "fermented foods", "kombucha", "kimchi", "yogurt", "antioxidant status", "oxidative stress", "gut health", and "gut microbiota". Included articles were published within the last 10 years, available in full text, written in English or Indonesian and relevant to the research topic. The selection process was carried out through the removal of duplications, screening of titles and abstracts, and assessment of full texts based on predetermined inclusion and exclusion criteria. Data from selected articles were analyzed descriptively-narratively by comparing results between studies, grouping findings based on the type of fermented food and health outcomes, and outlining the reported biological mechanisms, including increased antioxidant capacity, modulation of gut microbiota, and decreased oxidative stress, without conducting statistical meta-analysis due to heterogeneity of study designs and outcomes.

Table 1. Distribution of Articles Retrieved and Included in the Narrative Synthesis by Electronic Database

Electronic Database	Number of Articles Found	Articles Included in Synthesis
PubMed / MEDLINE	695	2
ScienceDirect	493	3
Google Scholar	3.550	5
Total	**4.738**	**10**

RESULT AND DISCUSSION

Based on the results of the literature search and selection conducted, several articles were obtained that met the inclusion criteria and were relevant to the research topic. The selected articles consisted of human clinical trials, experimental animal studies, and review articles discussing the consumption of fermented foods, particularly kombucha, kimchi, and yogurt, on antioxidant status and gastrointestinal health. The synthesis results showed that most studies reported increased antioxidant capacity, decreased oxidative stress markers, and improved gastrointestinal health parameters, primarily through modulation of the gut microbiota and increased fermentation metabolites. A summary of the characteristics and main findings of each study is systematically presented in the following synthesis table.

Table 2. Summary of Study Characteristics and Main Findings of Included Studies on the Health Effects of Fermented Foods

No	Author	Year	Article Title	Research purposes	Research result	Conclusion
1	Lloyd AJ, et al.	2025	*Daily consumption of kombucha influences the urinary and plasma metabolome*	Assessing the effect of daily kombucha consumption on metabolome and metabolite profiles related to gut health	Kombucha consumption significantly increases levels of short-chain fatty acids (SCFA), fermented organic acids, and lipid metabolites that play a role in gastrointestinal health and energy metabolism.	Kombucha has the potential to improve gastrointestinal health through metabolome modulation
2	Urrutia MAD et al.	2021	*Kombucha consumption improves antioxidant activity in rats*	Evaluating the antioxidant effects of kombucha in animal models	Kombucha consumption increases total antioxidant capacity (TAC), superoxide dismutase (SOD) activity, and reduces oxidative stress markers compared to controls.	Kombucha has significant systemic antioxidant activity
3	Antolak H, et al.	2021	*Kombucha Tea—A Double Power of*	Assessing the bioactive compounds and	Kombucha contains polyphenols, flavonoids, organic acids, and	Kombucha is a functional beverage with

			Bioactive Compounds	antioxidant activity of kombucha	vitamins, which experience increased bioavailability during fermentation, leading to high antioxidant activity.	antioxidant potential
4	Park JM, et al.	2021	*Microbiota changes with fermented kimchi intake*	Assessing changes in the gut microbiota after kimchi consumption	Kimchi consumption increases the proportion of beneficial bacteria such as Lactobacillus and Bifidobacterium and decreases pathogenic bacteria.	Kimchi plays a role in improving gut microbiota balance
5	Park JM, et al.	2020	*Fecal microbiota changes with fermented kimchi intake*	Evaluating the effects of kimchi on fecal microbiota and colonic inflammation	Increased gut microbiota diversity, increased probiotic bacteria, and decreased gut inflammation markers were found after kimchi intervention.	Kimchi has the potential to protect colon health
6	Song E, et al.	2023	*Effects of kimchi on human health: a scoping review of RCTs*	Summarizing the results of randomized clinical trials on the effects of kimchi on human health	The majority of RCTs showed improved digestive function, decreased inflammation, and improved metabolic parameters after kimchi consumption.	Clinical evidence supports kimchi as a functional food
7	Kim DW, et al.	2024	*Effects of Kimchi Intake on Gut Microbiota and Metabolomics*	Assessing the effects of kimchi consumption on the gut microbiota and metabolome	Kimchi consumption increases gut microbiota diversity and beneficial metabolites related to lipid metabolism and gastrointestinal health.	Kimchi provides digestive health benefits through metabolic mechanisms
8	Zolghadrpour M-A, et al.	2024	*Synbiotic yogurt improves oxidative stress status*	Assessing the effects of synbiotic yogurt on oxidative stress in humans	The synbiotic yogurt group showed decreased malondialdehyde (MDA) and increased SOD and total antioxidant capacity (TAC).	Synbiotic yogurt effectively improves antioxidant status
9	Yoon JW, et al.	2019	*Antioxidant activity of yogurt in colitis model*	Assessing the effects of yogurt on colonic inflammation and oxidative stress	Yogurt reduces colonic inflammation, reduced oxidative stress, and improved intestinal mucosal integrity in a colitis model.	Yogurt has a protective effect against inflammatory bowel disorders
10	Künili İE, et al.	2025	*Bioactive compounds in fermented foods*	Reviewing the effects of bioactive compounds in fermented foods on health	The fermentation process increases the bioavailability of antioxidants and probiotics, which positively impacts oxidative status and gastrointestinal health.	Regular consumption of fermented foods supports digestive health and oxidative balance

Effects of Fermented Foods on Antioxidant Status

The evidence synthesized in this review indicates that kombucha and yogurt contribute to antioxidant status through complementary pathways. Fermentation increases the availability of polyphenols, organic acids, and other microbial metabolites, while probiotic activity may support endogenous antioxidant defenses. This interpretation is consistent with broader reviews

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describing fermented foods as functional dietary sources that can influence redox regulation through several interconnected mechanisms (Künili et al., 2025; Sampsell et al., 2025). However, the magnitude of the effect cannot be assumed to be uniform across products because the concentration and bioavailability of these compounds depend on the raw material, microbial culture, fermentation conditions, storage, and consumed dose.

Kombucha provides the clearest mechanistic evidence for increased antioxidant activity in the reviewed literature (Antolak et al., 2021). In experimental animals, kombucha consumption increased total antioxidant capacity and superoxide dismutase activity while reducing markers of oxidative stress (Urrutia et al., 2021). These changes are biologically plausible because fermentation can transform complex tea constituents into forms that are more readily absorbed and can increase the availability of polyphenols and organic acids. Human metabolomic findings further suggest that daily kombucha consumption alters plasma and urinary metabolites, including compounds related to short-chain fatty acid metabolism (Lloyd et al., 2025). Nevertheless, the animal and metabolomic findings should not be interpreted as equivalent to confirmed clinical protection against oxidative-stress-related disease; rather, they provide convergent evidence of biological activity that requires confirmation in adequately powered human trials.

Yogurt, particularly synbiotic yogurt, also showed a favorable influence on redox balance. A randomized clinical trial reported lower malondialdehyde levels together with increased total antioxidant capacity and antioxidant enzyme activity after synbiotic yogurt consumption (Zolghadrpour et al., 2024). Animal evidence additionally indicates that yogurt can reduce oxidative stress and colonic inflammation while supporting mucosal integrity (Yoon et al., 2019). Taken together, these findings suggest that fermented foods may act not only as sources of exogenous antioxidants but also as stimuli for endogenous protective responses (Milani et al., 2026; Rani et al., 2021). The distinction between conventional yogurt and synbiotic formulations remains important, however, because their microbial composition and added prebiotics may produce different physiological effects.

Overall, the antioxidant findings are promising but heterogeneous. Differences in product formulation, fermentation method, intervention duration, participant characteristics, and measured biomarkers limit direct comparison between studies (Künili et al., 2025). Furthermore, evidence derived from experimental models cannot be generalized directly to human populations. Future research should therefore standardize product characterization, dosage, and outcome measurement and should determine whether changes in antioxidant biomarkers translate into meaningful clinical benefits.

Effects of Fermented Foods on Gastrointestinal Health

The gastrointestinal effects identified in this review are principally related to modulation of the gut microbiota, production of fermentation-derived metabolites, and preservation of the intestinal barrier. Kimchi has demonstrated particularly relevant effects on microbial composition (Park et al., 2021b). Human intervention evidence indicates increased proportions of beneficial bacteria, including *Lactobacillus* and *Bifidobacterium*, and reduced pathogenic bacteria following kimchi consumption (Park et al., 2021a). The reported increase in microbial diversity and reduction in colonic inflammatory markers provide a plausible link between kimchi intake and improved mucosal integrity (Song et al., 2023). Metabolomic evidence also suggests that kimchi-derived microbial activity produces metabolites associated with gastrointestinal and lipid metabolism (Kim et al., 2024). These findings support a microbiota-mediated effect, although variations in kimchi ingredients, salt content, fermentation stage, and microbial profile may influence the response.

Across the three fermented-food groups, short-chain fatty acids and organic acids appear to connect microbial modulation with intestinal function. These metabolites may strengthen epithelial tight junctions, reduce the translocation of pathogenic bacteria, regulate intestinal motility, provide energy to colonocytes, and modulate inflammatory signaling (Dimidi et al.,

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2019). This mechanism is consistent with evidence that bioactive compounds generated during fermentation support intestinal barrier function and host–microbe interactions (Künili et al., 2025). The metabolomic changes reported after kombucha intake, particularly those related to acetate, propionate, and butyrate, further reinforce this interpretation (Lloyd et al., 2025). Similarly, kimchi-associated metabolite changes suggest that benefits may arise not only from the microorganisms present in the food but also from their metabolic products (Kim et al., 2024).

Antioxidant regulation and gastrointestinal protection should therefore be understood as interrelated rather than independent outcomes. Reduced oxidative stress can help preserve epithelial integrity, whereas a more balanced microbiota and stronger intestinal barrier may reduce low-grade inflammation and the systemic oxidative burden (Dimidi et al., 2019). Fermentation also increases the bioavailability of phenolic compounds by breaking down complex structures into more absorbable forms (Antolak et al., 2021), which helps explain why fermented products may exhibit greater antioxidant activity than their non-fermented counterparts (Urrutia et al., 2021). This reciprocal relationship provides a coherent biological explanation for the simultaneous improvement in redox and gastrointestinal outcomes reported across the reviewed studies.

Despite the generally positive pattern, the evidence base remains insufficient for definitive dietary or therapeutic recommendations. Traditional and commercial fermented products differ substantially in microbial viability and bioactive-compound content, contributing to variation among study results (Dimidi et al., 2019). Moreover, the synthesis includes observational studies, small clinical trials, reviews, and experimental animal studies, which differ in their ability to establish causality. Fermented foods may therefore be considered a potentially safe, multifactorial dietary strategy for supporting gastrointestinal well-being and antioxidant balance, but not a substitute for established clinical treatment (Mukherjee et al., 2025). Large randomized trials using standardized products, clearly defined doses, adequate intervention periods, and comparable microbiota, inflammatory, and oxidative-stress outcomes are needed to determine effectiveness and optimal consumption patterns (Dimidi et al., 2019).

CONCLUSION

Based on the results of this literature review, the consumption of fermented foods such as kombucha, kimchi, and yogurt has been shown to have positive effects on improving antioxidant status and gastrointestinal health. Fermented foods play a role in increasing the body's antioxidant capacity by increasing the bioavailability of bioactive compounds and activating the endogenous antioxidant system, and contribute to maintaining the balance of the gut microbiota by increasing beneficial bacteria and producing fermented metabolites. Furthermore, fermented food consumption is associated with improved gastrointestinal function, reduced oxidative stress, and reduced low-grade inflammation in the gastrointestinal tract. However, variations in study design, type of fermented product, and duration and dosage between studies indicate the need for large-scale randomized clinical trials with standardized methods to strengthen causal evidence and determine optimal consumption recommendations in the future.

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