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THE ROLE OF DIETARY FIBER AND PROBIOTICS IN IMPROVING LIPID PROFILE IN OBESITY: A LITERATURE REVIEW

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ABSTRACT
Obesity is a major public health problem that is closely associated with dyslipidemia and an increased risk of metabolic and cardiovascular diseases. Dietary fiber and probiotics have been widely explored as non-pharmacological dietary approaches to improve lipid profiles in obesity; however, evidence from experimental and clinical studies remains fragmented and requires systematic synthesis. This literature review aimed to synthesise current evidence on the role of dietary fiber and probiotics in improving lipid profiles under obese or metabolically compromised conditions. A literature search was conducted using Google Scholar, PubMed, and ScienceDirect to identify relevant studies published between 2020 and 2025. Studies assessing the effects of dietary fiber or probiotic interventions on lipid profile parameters in animal models or human subjects with obesity or metabolic disorders were included. The initial search resulted in 274 articles, which were subsequently screened for eligibility based on predefined inclusion and exclusion criteria. After screening, Six eligible studies met the inclusion criteria and were analysed qualitatively. The included studies consistently demonstrated that dietary fiber and probiotic interventions were associated with improvements in lipid profiles, including reductions in total cholesterol, triglycerides, and low-density lipoprotein cholesterol, alongside increases in high-density lipoprotein cholesterol. Several studies also reported concurrent reductions in body weight, visceral fat accumulation, or glycaemic parameters, indicating broader metabolic benefits. Dietary fiber and probiotics show potential as complementary, non-pharmacological strategies for improving lipid profiles in obesity. These findings support the development of functional food formulations incorporating fiber- and probiotic-based components.

Keywords: dietary fibre; lipid profile; obesity; probiotic; sorghum

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INTRODUCTION
In the last three decades, the world has experienced an epidemiological transition characterized by a shift in the burden of disease from infectious diseases to non-communicable diseases (NCDs) (Gulis et al., 2025). One NCD of global concern is obesity, which the World Health Organization (WHO) has categorized as a global epidemic. It is estimated that by 2035, more than 4 billion people worldwide will be overweight and obese. This figure reflects an increase from 38% of the world's population in 2020 to more than 50% in 2035. The global prevalence of obesity is also projected to increase from 14% in 2020 to 24% in 2035, affecting nearly 2 billion adults, children, and adolescents worldwide (Lobstein, Hannah Brinsden, 2022).

In Indonesia, the obesity trend shows an increase, which is based on the 2023 Indonesian Health Survey (SKI) which again shows an increase in obesity prevalence to 23.4% (Kementrian Kesehatan RI, 2023). Obesity is a pathological condition resulting from excessive fat accumulation in the body which causes an increase in body weight beyond the ideal proportions based on the skeletal structure and the physiological needs of the body (Negrea et al., 2021). Obesity significantly impacts health, acting as a trigger for various non-communicable diseases (NCDs).

This condition increases susceptibility to metabolic syndrome, characterized by insulin resistance, impaired glucose tolerance, and dyslipidemia. (Prihaningtyas et al., 2020).

Dyslipidemia is one of the main metabolic complications of obesity, contributing to an increased risk of cardiovascular disease. Research by Nurhidayati et al. (2022) shows that obesity increases the risk of blood lipid levels in adolescents in Indonesia, particularly total cholesterol, LDL cholesterol, and triglycerides. Furthermore, research by Giudetti (2023) shows that obesity is often accompanied by lipid profile disturbances characterized by increased triglycerides, decreased HDL cholesterol levels, and changes in the quality and quantity of LDL cholesterol. Therefore, efforts to prevent and control obesity by improving lipid profiles are important strategies in reducing the risk of metabolic and cardiovascular complications. One approach considered effective and sustainable in this effort is the use of functional foods(Almunawar Muhammad, 2023).

One local food ingredient with the potential to be developed as a functional food is sorghum (Sorghum bicolor (L.) Moench). Sorghum contains diverse nutrients, including dietary fiber, a low glycemic index, and bioactive compounds such as polyphenols and tannins, which act as antioxidants. The dietary fiber content in sorghum plays a role in obesity control by increasing satiety, slowing glucose and fat absorption, and reducing food energy density. These mechanisms contribute to improved fat metabolism, so sorghum consumption has the potential to help lower triglyceride and total cholesterol levels in obese individuals (Waddell et al., 2023).

In addition to dietary fiber, probiotics, a crucial component of functional foods that play a role in regulating lipid metabolism, are probiotics, which generally come from the Lactic Acid Bacteria (LAB) group. Probiotics are known to modulate the gut microbiota, influence fat absorption, and play a role in regulating lipid metabolism and the inflammatory response. Research by Haliman et al., (2021) states that probiotics show potential to help overcome obesity by influencing dietary fat absorption, increasing satiety, and reducing body fat accumulation. In line with this, research by Wulandari et al., (2025) shows that administering curd to obese mice can increase adiponectin levels and decrease Tumor Necrosis Factor-Alpha (TNF-α) levels, both of which play a role in regulating inflammation and fat metabolism, thus contributing to improving lipid profiles in obese conditions.

Although numerous studies have examined the role of dietary fiber and probiotics in the management of obesity and metabolic disorders, scientific evidence specifically addressing the effects of these two components on improving lipid profiles in obesity remains scattered and shows varying results. Differences in study designs, intervention types, and subject models (animal and human) necessitate a structured and comprehensive literature synthesis. Therefore, this literature review aims to synthesize scientific evidence on the role of dietary fiber and probiotics in improving lipid profiles in obesity, as a basis for developing functional food interventions to prevent and control obesity-related dyslipidemia.

METHOD

This study employed a literature review approach to examine research findings related to the role of dietary fiber and probiotics in improving lipid profiles in obesity. The literature analysis was conducted through several stages, including literature organisation, data synthesis, identification of relevant findings, and further analytical interpretation.

Scientific articles were obtained from national and international publications indexed in three major databases: Google Scholar, ScienceDirect, and PubMed. The literature search was conducted using combinations of keywords such as “obesity,” “dietary fiber,” “probiotics,” “lipid profile,” “dyslipidemia,” “cholesterol,” “sorghum,” “fermented milk,” and “lactic acid bacteria,” combined using Boolean operators (AND/OR). The publication period was limited to studies published between 2020 and 2025 to ensure the inclusion of recent and relevant evidence. All identified articles were downloaded using Mendeley Desktop version 1.19.8, and duplicate entries were manually removed before further screening.

The literature review process was performed systematically. Initially, the articles were screened based on title and abstract relevance, followed by further evaluation of the full-text articles for their alignment with the objectives of the review. Articles that met the inclusion criteria were considered for the final analysis. The inclusion criteria were as follows: (1) Original research articles evaluating the role or effects of dietary fiber and/or probiotics on lipid profile improvement in obesity. (2) Studies conducted in human subjects or animal models. (3) Articles published between 2020 and 2025 in English or Indonesian. (4) Full-text articles with clearly described research methodologies and measurable lipid profile outcomes.

The exclusion criteria included: (1) Articles that did not specifically address the role of dietary fiber or probiotics in lipid profile modulation under obese conditions. (2) Studies focusing on unrelated topics, such as general nutrition or diseases not associated with obesity. (3) Articles lacking quantitative data on lipid parameters or body weight outcomes. (4) Non-research publications, such as opinion-based narrative reviews, conference abstracts, editorials, or descriptive reports without analytical data.

Each article that met the inclusion criteria was classified according to author, year of publication, study design, study population or experimental model, intervention characteristics, and key findings related to obesity and lipid profiles. The final stage of analysis involved thematic synthesis and comparative evaluation of findings across studies to draw general conclusions regarding the role of dietary fiber and probiotics in improving lipid profiles in obesity.

RESULT

The literature search across Google Scholar, PubMed, and ScienceDirect identified a total of 274 articles. After removing duplicate records and screening titles and abstracts for relevance, 28 articles were selected for full-text assessment. Following full-text evaluation based on predefined inclusion and exclusion criteria, six studies were deemed eligible and included in the final analysis. The characteristics and main findings of the included studies are summarised in Table 1.

Table 1.
Characteristics of Included Studies on Dietary Fiber and Probiotics in Improving Lipid Profiles in Obesity

Title/ Author (Year)	Study Design	Subject / Model	Intervention	Outcome	Findings
Sorghum flour's effect on improving plasma lipid profile and atherogenic index in diabetic rats (Setyowati et al., 2023)	True experimental study with pre-and post-tests and a control group design	Streptozotocin–nicotinamide-induced diabetic male Wistar rats (Rattus norvegicus)	Sorghum flour supplementation (5 g/rat/day for 28 days)	Total cholesterol, triglycerides, LDL-C, HDL-C, and plasma atherogenic index (IAP)	Sorghum flour significantly reduced total cholesterol, triglycerides, LDL, and IAP, and increased HDL levels in diabetic rats.
Effects of a Sorghum Beverage with Lacticaseibacillus paracasei on Body Composition,	Randomized single-blind controlled pilot study	Overweight and obese adults (BMI 27.0–34.9	Extruded whole-grain sorghum beverage with or without Lacticaseibacillus paracasei consumed daily	Lipid profile (total cholesterol, LDL-C, HDL-C, triglycerides, Castelli	The combination of sorghum and probiotics (LAB) was associated with improvements in lipid-related indices (Castelli index), reductions in visceral fat,

Title/ Author (Year)	Study Design	Subject / Model	Intervention	Outcome	Findings
Lipid Profiles, and Intestinal Health in Overweight and Obese Adults (Aguiar et al., 2024)		kg/m²)	for 10 weeks	index I)	and improved gut health in overweight or obese individuals.
Dietary Fibres and the Management of Obesity and Metabolic Syndrome: The RESOLVE Study (Tremblay et al., 2020)	Randomized controlled trial (secondary analysis, single-blind)	Adults with metabolic syndrome (aged 50–70 years; overweight/obese)	Intensive 3-week supervised diet–exercise program followed by 12-month follow-up; increased dietary fiber intake as part of dietary intervention	Body composition (BMI, fat mass, central fat), lipid profile (total cholesterol, LDL-C, HDL-C, triglycerides), glycemic and inflammatory markers	Dietary fiber intake nearly doubled during the intensive intervention and remained significantly higher than baseline during follow-up. Fiber intake was the only nutritional factor that consistently and significantly predicted improvements in body composition and metabolic outcomes, including reductions in central fat and favorable changes in lipid profile.
Anti-obesity effects of potential probiotic Lactobacillus strains isolated from Mongolian fermented dairy products in high-fat diet induced obese rodent model (Galindev et al., 2024)	True experimental animal study with randomized controlled design	High-fat diet–induced obese male C57BL/6J mice	Oral administration of probiotic LAB strains (Lacticaseibacillus paracasei X-1, Lacticaseibacillus paracasei X-17, and Limosilactobacillus fermentum BM-325) at 5×10⁹ CFU/day for 6 weeks	Body weight, lipid profile (TC, TG, LDL-C, HDL-C), fasting blood glucose, adipose tissue index, liver morphology	Administration of Lacticaseibacillus paracasei and Limosilactobacillus fermentum for 6 weeks to mice on a high-fat diet resulted in weight loss and stabilization of fasting blood glucose levels. The lipid profile also showed a decrease in LDL and triglycerides (TG), as well as stabilization of HDL.
Sorghum-Soybean Flour Enteral Formula Reduces Blood Glucose, Cholesterol, Triglycerides, LDL, and Increases HDL and Albumin in Hyperglycemic Rats (Probosari et al., 2025)	True experimental pre-clinical study with randomized pre–post-test control group design	Streptozotocin–nicotinamide–induced hyperglycemic male Wistar rats (Rattus norvegicus)	Enteral formula based on sorghum–soybean flour administered at two doses (4.41 g/day and 5.51 g/day) for 28 days	Lipid profile (total cholesterol, triglycerides, LDL-C, HDL-C), fasting blood glucose, albumin	Administration of an enteral formula based on sorghum and soybean flour to hyperglycemic rats significantly reduced fasting blood sugar (FBG), total cholesterol, triglycerides, and LDL levels, while increasing HDL and serum albumin levels.
Effects of probiotic fermented milk on management of obesity studied in high-fat-diet induced obese rat model	True experimental animal study with randomized controlled design	High-fat diet–induced obese male Wistar rats (Rattus	Daily oral administration of probiotic fermented milk with or without whey protein concentrate (WPC) and soy	Lipid profile (total cholesterol, triglycerides, LDL-C, HDL-C), body weight, abdominal	Administering probiotic fermented milk for 4 weeks to obese rats induced by a high-fat diet reduced body weight, triglycerides, and total cholesterol, and showed significant

Title/ Author (Year)	Study Design	Subject / Model	Intervention	Outcome	Findings
(Makwana et al., 2023)		norvegic us)	protein isolate (SPI) (2 mL/day for 4 weeks)	fat, liver enzymes, leptin	improvements in lipid profiles compared to the control group.

Overall, the six included studies consistently demonstrated that dietary fiber and probiotic interventions were associated with improvements in lipid profiles under obese or metabolically compromised conditions. Experimental animal studies reported reductions in total cholesterol, triglycerides, and LDL levels, along with increases in HDL concentrations following sorghum-based fiber or probioticC interventions. Human studies similarly indicated favorable changes in lipid-related indices, particularly improvements in the Castelli index and reductions in visceral fat among overweight and obese adults. Several studies also reported concurrent improvements in body weight, adiposity, or glycemic parameters, suggesting broader metabolic benefits. Collectively, these findings highlight the potential role of dietary fiber and probiotics in improving lipid profiles in obesity, as summarized in Table 1.

DISCUSSION

This literature review synthesised evidence from six experimental and clinical studies to examine the role of dietary fiber and probiotics in improving lipid profiles under obese or metabolically compromised conditions. Overall, the findings consistently indicate that interventions involving dietary fiber—particularly fiber derived from sorghum-based products—and probiotic supplementation are associated with favourable modulation of lipid parameters, including reductions in total cholesterol, triglycerides, and low-density lipoprotein cholesterol (LDL-C), along with increases in high-density lipoprotein cholesterol (HDL-C). These effects were observed across diverse experimental models, including high-fat diet–induced obese animals, hyperglycaemic or diabetic rodent models, and overweight or obese human subjects, suggesting that the lipid-modulating potential of dietary fiber and probiotics is robust across varying metabolic conditions. In addition to lipid improvements, several studies also reported concurrent reductions in body weight, visceral fat accumulation, or glycaemic parameters, highlighting the broader metabolic relevance of these interventions in obesity management.

Dietary Fiber and Lipid Profile Improvement in Obesity

Dietary fiber has been consistently identified as a key nutritional component contributing to improvements in lipid profiles in individuals with obesity or metabolic disorders. Evidence from the included studies indicates that fiber-based interventions, particularly those derived from sorghum and other whole-grain sources, are associated with reductions in total cholesterol, triglycerides, and LDL-C, along with increases in HDL-C across both animal and human studies (Jia et al., 2025). These findings support the role of dietary fiber as an effective non-pharmacological strategy for mitigating dyslipidemia commonly observed in obesity.

The lipid-lowering effects of dietary fiber may be explained through several complementary mechanisms. Soluble fiber can bind bile acids in the intestinal lumen, enhancing bile acid excretion and stimulating hepatic conversion of cholesterol into bile acids, thereby reducing circulating cholesterol levels (Bakr et al., 2023). In addition, fermentation of dietary fiber by gut microbiota produces short-chain fatty acids (SCFAs), such as acetate, propionate, and butyrate, which have been reported to inhibit hepatic cholesterol synthesis and improve lipid metabolism (Nogal et al., 2021). Dietary fiber also enhances satiety, reduces energy intake, and modulates postprandial glycaemic responses by slowing gastric emptying and carbohydrate absorption, thereby attenuating insulin fluctuations linked to lipid synthesis and fat accumulation (Haliman et al., 2021).

Recent studies have further elaborated on the specific effects of fiber from various sources on lipid metabolism. For example, the incorporation of oats and barley fiber has been shown to improve lipid profiles by enhancing bile acid excretion and modulating the gut microbiome, demonstrating a complementary mechanism alongside sorghum fiber (Li et al., 2022).

Experimental animal studies included in this review demonstrated that sorghum-based fiber supplementation significantly improved lipid parameters under diabetic or hyperglycaemic conditions, indicating that fiber intake may exert protective effects even in the presence of metabolic stress (Setyowati et al., 2023). Similarly, human-based interventions showed that increased dietary fiber intake was associated with favourable changes in lipid-related indices and reductions in central or visceral adiposity among overweight and obese adults (Tremblay et al., 2020). Collectively, these findings underscore the relevance of dietary fiber in addressing both lipid abnormalities and adiposity as interconnected components of obesity-related metabolic dysfunction.

Role of Probiotics in Modulating Lipid Metabolism

Probiotic supplementation has been increasingly recognised as a promising dietary approach for improving lipid metabolism in obesity and related metabolic disorders. Evidence from the studies included in this review demonstrates that probiotic-based interventions, such as probiotic fermented milk and probiotic-enriched sorghum beverages, were associated with favourable changes in lipid profiles, including reductions in triglycerides and LDL-C, as well as maintenance or increases in

HDL-C (Makwana et al., 2023; Galindev et al., 2024; Aguiar et al., 2024). Probiotics, particularly those from the Lacticaseibacillus and Limosilactobacillus strains, have been shown to modulate the gut microbiota, potentially enhancing the absorption of beneficial fatty acids while reducing harmful lipids (Min You et al., 2025).

Animal studies reported that supplementation with probiotic strains such as *Lacticaseibacillus paracasei* and *Limosilactobacillus fermentum* resulted in improvements in lipid parameters alongside reductions in body fat accumulation in high-fat diet–induced obese rodents (Makwana et al., 2023; Galindev et al., 2024). Similarly, probiotic fermented milk interventions were associated with reductions in body weight and adiposity, suggesting that probiotics may exert lipid-modulating effects in parallel with anti-obesity benefits (Makwana et al., 2023).

In human studies, consumption of probiotic-enriched sorghum beverages was associated with improvements in lipid-related indices, particularly reductions in cardiovascular risk markers such as the Castelli index, as well as favourable changes in visceral fat and gut health indicators among overweight and obese adults (Aguiar et al., 2024). Although not all lipid parameters showed statistically significant changes, the observed trends support a contributory role of probiotics in improving lipid metabolism when administered as part of a functional food matrix.

Practical Implications

The findings of this review suggest that both dietary fiber and probiotics could play a significant role in managing obesity-related lipid abnormalities. These interventions, particularly through the inclusion of sorghum-based products and fermented probiotic foods, present promising non-pharmacological approaches to improve lipid profiles and overall metabolic health. The practical application of these interventions may involve incorporating fiber-rich foods such as sorghum, oats, and barley into daily diets to reduce cholesterol and triglyceride levels, as well as to enhance satiety, which is crucial for managing obesity. Additionally, functional foods enriched with probiotics—such as yogurt, kefir, or probiotic-enriched sorghum beverages can serve as effective dietary strategies for individuals struggling with dyslipidemia (Khalid et al., 2022).

For clinicians and nutritionists, the results suggest that recommending dietary fiber and probiotic supplementation as part of a holistic approach to managing obesity and cardiovascular risk could be a beneficial adjunct to pharmacological treatments. Incorporating these interventions into dietary guidelines may help improve patient adherence to treatment, especially given the growing demand for natural, sustainable dietary solutions in managing chronic diseases (Rodriguez et al., 2022). Moreover, developing probiotic-based functional foods can provide a more practical and enjoyable means for individuals to improve their metabolic health on a daily basis,

Strengthening the Mechanism of Probiotics in Lipid Metabolism
Probiotics exert their lipid-modulating effects through several mechanisms that have become more evident in recent studies. The impact of probiotics on gut microbiota modulation is central to their action, as they influence the gut's capacity to digest and absorb lipids. Probiotics such as Lactobacillus and Bifidobacterium have been shown to enhance the production of short-chain fatty acids (SCFAs), such as butyrate, acetate, and propionate, which act in several ways to reduce lipid accumulation. SCFAs have been reported to inhibit cholesterol biosynthesis in the liver, which leads to a reduction in blood cholesterol levels. Moreover, SCFAs play a crucial role in increasing gut barrier function, thereby reducing systemic inflammation, which is often elevated in individuals with obesity and dyslipidemia (Markowiak Kope et al., 2020).

Additionally, probiotic supplementation has been found to reduce inflammation in the gut and throughout the body, which is crucial in obesity-related lipid abnormalities. Chronic inflammation often disrupts lipid metabolism by promoting the production of pro-inflammatory cytokines such as TNF-α and IL-6. Probiotics have been shown to reduce these cytokines, helping to restore normal lipid metabolism. This anti-inflammatory effect of probiotics complements their ability to regulate lipid levels, especially in the context of obesity-related diseases such as cardiovascular disease and diabetes (Mukarromah et al., 2025). Studies have further emphasized the synergistic effect of combining dietary fiber with probiotics. When both dietary fiber (as prebiotics) and probiotics are included in the diet, they enhance each other's effects in modulating gut health, improving lipid profiles, and reducing adiposity (Lauw et al., 2023).

Consistency and Variability of Findings Across Studies
Across the six studies included in this review, a generally consistent pattern was observed regarding the beneficial effects of dietary fiber and probiotic interventions on lipid profiles in obesity and related metabolic conditions. Experimental animal studies demonstrated more pronounced and consistent lipid-lowering effects, likely due to controlled dietary intake, standardised intervention protocols, and homogeneous experimental conditions. In contrast, human-based studies reported more modest improvements, with significant changes often observed in composite lipid-related indices rather than individual lipid fractions.

Variability in study outcomes may be attributed to differences in study design, intervention duration, dietary composition, fiber type, probiotic strain, dosage, and the inclusion of combined lifestyle interventions. For instance, interventions integrating increased dietary fiber intake with structured diet and exercise programs appeared to yield broader metabolic benefits compared with single-component dietary approaches (Tremblay et al., 2020). This suggests the potential for synergistic effects when dietary interventions are combined with physical activity, as supported by a recent study by (Rodriguez et al., (2022), which demonstrated that combining fiber supplementation with exercise provided superior metabolic outcomes in obese participants.

Despite these variations, the overall direction of findings consistently supports the role of dietary fiber and probiotics in improving lipid profiles and related metabolic parameters in obesity, while underscoring the need for further well-designed human trials to clarify optimal intervention strategies (Aguiar et al., 2024).

CONCLUSION
This literature review indicates that dietary fiber and probiotic interventions are consistently associated with improvements in lipid profiles under obese or metabolically compromised

conditions. Evidence from experimental animal and human studies indicates that fiber-rich foods, particularly those derived from sorghum, contribute to reductions in total cholesterol, triglycerides, and LDL-C, alongside increases in HDL-C. Similarly, probiotic-based interventions, including fermented milk products and probiotic-enriched sorghum beverages, show potential in modulating lipid metabolism and reducing obesity-related metabolic risk markers.

Despite variations in study design, intervention duration, and outcome magnitude, the overall direction of findings supports the role of dietary fiber and probiotics as complementary, non-pharmacological strategies for managing dyslipidemia associated with obesity. The integration of these components into functional food formulations may offer a promising approach to improving lipid profiles and metabolic health.

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