



## Effectiveness of Ginger in Reducing Inflammation Markers in Metabolic Diseases

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### Abstract

Metabolic diseases, including type 2 diabetes mellitus, obesity, metabolic syndrome, dyslipidemia, and non-alcoholic fatty liver disease, are commonly associated with chronic low-grade inflammation. Ginger (*Zingiber officinale*) contains bioactive compounds with anti-inflammatory and antioxidant properties that may support the management of these conditions. This literature review aimed to evaluate the effectiveness of ginger supplementation in reducing inflammatory markers in patients with metabolic diseases. Articles published between 2021 and 2026 were identified through PubMed, Scopus, ScienceDirect, SpringerLink, and Google Scholar using combinations of keywords related to ginger, metabolic diseases, and inflammatory markers. Articles were selected based on predefined inclusion criteria, and 15 studies were included in the final synthesis. Most studies reported that ginger supplementation reduced major inflammatory markers, particularly C-reactive protein, high-sensitivity C-reactive protein, tumor necrosis factor-alpha, and interleukin-6. Ginger also produced additional improvements in fasting blood glucose, glycated hemoglobin, insulin resistance, lipid profiles, body weight, body composition, and antioxidant status. These effects are primarily attributed to gingerol, shogaol, paradol, and zingerone, which inhibit nuclear factor-kappa B activation, suppress pro-inflammatory cytokine production, and strengthen antioxidant defenses. Overall, ginger shows potential as a safe, accessible, and economical complementary intervention for controlling inflammation in metabolic diseases. Nevertheless, further clinical trials with larger samples and standardized dosages, formulations, and intervention periods are needed to confirm its clinical effectiveness.

## Introduction

Metabolic diseases are a group of health disorders characterized by metabolic abnormalities, such as obesity, type 2 diabetes mellitus, metabolic syndrome, dyslipidemia, and non-alcoholic fatty liver disease (NAFLD). These diseases are a global health problem with increasing prevalence and contributing to high morbidity and mortality rates due to cardiovascular disease, kidney disorders, and other systemic complications. One of the main pathophysiological mechanisms underlying the development of metabolic diseases is persistent chronic low-grade inflammation in the body (Cifuentes et al., 2024; Balderas-Peña et al., 2023; Khanna et al., 2022; Püschel et al., 2022). This chronic inflammation is characterized by elevated levels of various inflammatory markers such as C-reactive protein (CRP), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF- $\alpha$ ), which play a role in insulin resistance, endothelial

dysfunction, oxidative stress, and the progression of metabolic diseases (Musazadeh et al., 2026; Stanimirovic et al., 2022; Varra et al., 2024; Tylutka et al., 2024; Chopra et al., 2024).

In recent decades, the prevalence of metabolic diseases has shown a significant upward trend in line with changes in modern lifestyles, including the consumption of high-calorie, low-fiber foods, lack of physical activity, and rising obesity rates (Clemente-Suárez et al., 2023; Retiaty et al., 2025). This situation has prompted the need to develop effective, safe, and accessible prevention and therapeutic strategies. In addition to conventional pharmacological therapies, the use of natural ingredients as complementary therapies is gaining increasing attention due to their perceived lower side effects and potential broad benefits in various metabolic disease pathogenesis pathways (Zhou et al., 2023; Zhang et al., 2023; Latif & Nawaz, 2026; Shaik Mohamed Sayed et al., 2023).

One of the most widely studied herbal plants is ginger, or *Zingiber officinale* Roscoe. Ginger has long been used in traditional medicine as an anti-inflammatory, antioxidant, antihyperglycemic, and cardioprotective agent. These biological activities primarily stem from its bioactive compounds, such as 6-gingerol, 8-gingerol, 10-gingerol, and 6-shogaol, which are capable of modulating various inflammatory pathways and oxidative stress in the body. Various experimental studies have shown that ginger's active compounds can inhibit nuclear factor-kappa B (NF-κB) activation, reduce pro-inflammatory cytokine production, reduce reactive oxygen species (ROS) formation, and enhance endogenous antioxidant capacity. These mechanisms have the potential to improve metabolic disorders associated with chronic inflammation (Zhang et al., 2022; Varra et al., 2024; Zhao et al., 2023).

Clinical evidence regarding ginger's effectiveness against inflammatory markers is also growing. A recent umbrella review involving 36 publications, 296 clinical trials, and over 43,000 participants showed that ginger supplementation was consistently associated with a reduction in CRP levels of 0.42–1.00 mg/L and IL-6 levels of 0.45–2.26 pg/mL. Furthermore, ginger was also reported to improve glycemic profiles, insulin resistance, lipid profiles, and oxidative stress parameters, which are important components of metabolic disease. These findings suggest that ginger has potential as a non-pharmacological intervention that can simultaneously target multiple aspects of metabolic disease pathophysiology (Musazadeh et al., 2026; Askari & Aghajani, 2020).

Another study in patients with non-alcoholic fatty liver disease (NAFLD), a manifestation of metabolic disease with increasing prevalence, showed that ginger supplementation improved various metabolic and inflammatory parameters. These effects are thought to be related to ginger's ability to reduce oxidative stress, improve insulin sensitivity, and inhibit the production of inflammatory mediators that contribute to the progression of NAFLD (Zhou et al., 2023; Ghoreishi et al., 2024; Panyod et al., 2024; Bellucci et al., 2023).

Although various studies have reported the benefits of ginger on inflammatory and metabolic parameters, the results still show considerable variation in dosage, intervention duration, population characteristics, type of metabolic disease studied, and inflammatory markers used as outcome measures. Furthermore, most studies focus on specific metabolic diseases, so evidence regarding ginger's effectiveness on inflammatory markers across the entire spectrum of metabolic diseases is scattered and has not been comprehensively synthesized (Asghari-Jafarabadi & Khalili, 2022). Based on this description, a systematic literature review is needed to identify, analyze, and synthesize the latest scientific evidence regarding the effectiveness of ginger in reducing inflammatory markers in various metabolic diseases. The results of this literature review are expected to provide a more comprehensive picture of ginger's potential as a complementary therapy in the management of metabolic diseases and serve as a basis for further research and evidence-based clinical implementation.

## Methods

### Study Design

This study employed a literature review method, which involves identifying, examining, evaluating, and synthesizing published research findings related to the effectiveness of ginger (*Zingiber officinale*) in reducing inflammatory markers in metabolic diseases. This method aims to obtain a comprehensive overview of the latest scientific evidence related to the use of ginger as an anti-inflammatory agent in various metabolic diseases, based on published research findings.

### Research Timeline

The study was conducted from May to July 2026. Research activities included: (1) Preparation of a research proposal; (2) Literature search; (3) Selection of articles based on inclusion and exclusion criteria; (4) Data extraction; (5) Analysis and synthesis of research results; (6) Preparation of a thesis report. The data used in this study were secondary data obtained from published scientific articles. Literature sources were obtained through international databases, namely: (1) PubMed; (2) Scopus; (3) ScienceDirect; (4) SpringerLink; (5) Google Scholar.

### Literature Search Strategy

Article searches were conducted using keyword combinations tailored to each database.

### Keywords

English: ("Ginger" OR "Zingiber officinale") AND ("Inflammatory Marker" OR "Inflammation" OR "C-Reactive Protein" OR "CRP" OR "Interleukin-6" OR "IL-6" OR "Tumor Necrosis Factor Alpha" OR "TNF- $\alpha$ ") AND

("Metabolic Disease" OR "Metabolic Syndrome" OR "Type 2 Diabetes Mellitus" OR "Obesity" OR "Dyslipidemia" OR "Non-Alcoholic Fatty Liver Disease")

### Literature Selection Criteria

Literature selection was conducted to ensure that the articles used were appropriate to the research objectives and of good scientific quality. Selected articles must meet the following criteria.

Table 1. Literature Selection Criteria

| No | Literature Selection Criteria                                                                                                                                                                                                                                                                        |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1  | This article is an original research article.                                                                                                                                                                                                                                                        |
| 2  | The article was published between 2021 and 2026.                                                                                                                                                                                                                                                     |
| 3  | The full text of the article is available and can be accessed in its entirety.                                                                                                                                                                                                                       |
| 4  | The article is written in Indonesian or English.                                                                                                                                                                                                                                                     |
| 5  | The study involved human subjects with metabolic diseases, such as type 2 diabetes mellitus, obesity, metabolic syndrome, dyslipidemia, or non-alcoholic fatty liver disease (NAFLD).                                                                                                                |
| 6  | The intervention used was the administration of ginger ( <i>Zingiber officinale</i> ) in various dosage forms, such as extracts, capsules, powders, drinks, or other preparations.                                                                                                                   |
| 7  | The study evaluated the effect of ginger on inflammatory markers, such as C-reactive protein (CRP), high-sensitivity C-reactive protein (hs-CRP), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF- $\alpha$ ), interleukin-1 $\beta$ (IL-1 $\beta$ ), or other relevant inflammatory markers. |
| 8  | Articles use quantitative intervention research designs, such as randomized controlled trials (RCTs), clinical trials, or quasi-experimental studies.                                                                                                                                                |
| 9  | Articles are from reputable scientific journals indexed in international databases such as Scopus, PubMed, ScienceDirect, or SpringerLink.                                                                                                                                                           |

|    |                                                                                                                                                                              |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 | Articles present data and research results relevant to the research objectives regarding the effectiveness of ginger in reducing inflammatory markers in metabolic diseases. |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Literature Selection Process

The literature selection process is carried out through several stages, namely; (1) Search for articles in predetermined databases using appropriate keywords; (2) Identify articles based on titles and abstracts that are relevant to the research topic; (3) Review full-text articles to ensure compliance with the literature selection criteria; (4) Final selection of articles that meet all criteria for further analysis in the research; (5) Organize selected articles into data extraction and literature synthesis tables.

The article selection process will be presented in the form of a PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart to illustrate the stages of identification, screening, eligibility assessment, and the number of articles used in the research.

### Operational Framework

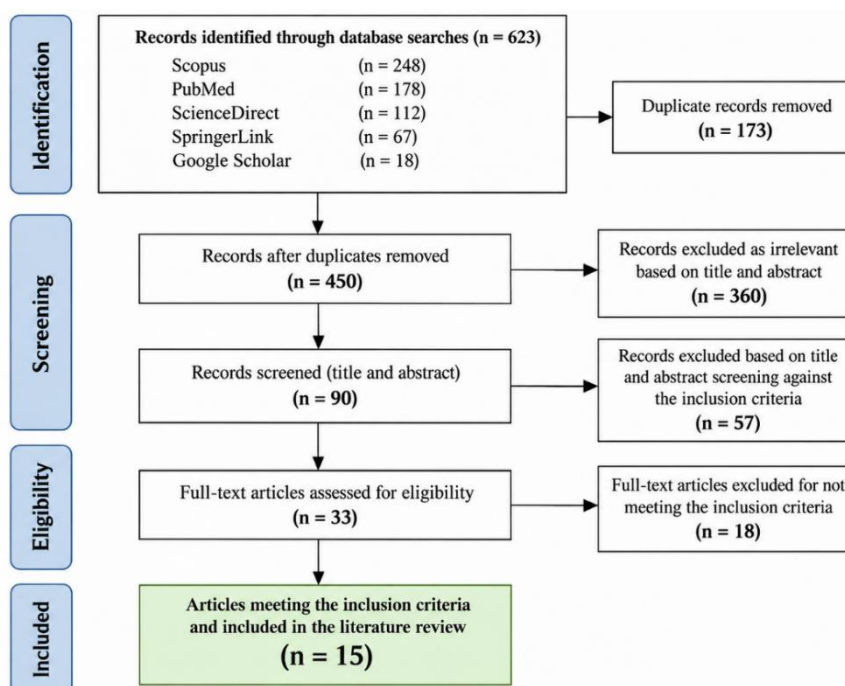


Figure 1. Chart 3 PRISMA Flow Chart Diagram

### Result and Discussion

Table 2. Characteristics and Summary of Included Studies on Ginger Supplementation and Inflammatory Markers in Metabolic Diseases

| No | Author            | Title and Publication                                                                                                                                           | Research Design   | Research Variables                                                                                 | Results                                                                                             |
|----|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| 1  | Zhou et al., 2023 | <i>Ginger Supplementation for the Treatment of Non-Alcoholic Fatty Liver Disease: A Meta-analysis of Randomized Controlled Trials (African Health Sciences)</i> | Meta-analysis RCT | Independent: Ginger supplementation;<br>Dependent: CRP, TNF- $\alpha$ , HOMA-IR, metabolic profile | Ginger provides significant improvements in inflammatory and metabolic parameters in NAFLD patients |

|   |                               |                                                                                                                                                                                                                 |                                         |                                                                        |                                                                                                                                                                                                                                                |
|---|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 | Ebrahimzadeh et al., 2022     | <i>The Effect of Ginger Supplementation on Metabolic Profiles in Patients with Type 2 Diabetes Mellitus (Complementary Therapies in Medicine)</i>                                                               | Systematic Review dan Meta-analysis RCT | Ginger; blood glucose, HbA1c, insulin resistance, inflammatory markers | Ginger supplementation improves metabolic profile and reduces inflammation in type 2 DM patients                                                                                                                                               |
| 3 | Rahimlou et al., 2026         | <i>Ginger Supplementation in Nonalcoholic Fatty Liver Disease (Hepatitis Monthly)</i>                                                                                                                           | Double-blind RCT                        | Ginger 2 g/day; inflammatory cytokine, HOMA-IR                         | There was a decrease in inflammatory cytokines, insulin resistance, and the degree of liver steatosis after 12 weeks of intervention                                                                                                           |
| 4 | Mohammad et al., 2021         | <i>The effects of the ginger supplements on inflammatory parameters in type 2 diabetes patients: A systematic review and meta-analysis of randomised controlled trials (Clin Nutr ESPEN)</i>                    | RCTs                                    | Ginger; hs-CRP, TNF- $\alpha$                                          | Ginger reduced hs-CRP and TNF- $\alpha$ compared to the control group                                                                                                                                                                          |
| 5 | Morvaridzadeh et al., 2021    | <i>Effect of ginger (Zingiber officinale) on inflammatory markers: A systematic review and meta-analysis of randomized controlled trials (Cytokines)</i>                                                        | RCTs                                    | Ginger; CRP, hs-CRP, IL-6, sICAM, and TNF- $\alpha$                    | There was a significant decrease in proinflammatory cytokines after ginger supplementation.                                                                                                                                                    |
| 6 | Rjabi et al., 2025            | <i>Antioxidant and Anti-inflammatory Effects of Ginger Supplementation in Adults: A GRADE-Assessed Systematic Review and Dose-Response Meta-analysis of Randomised Controlled Trials (Inflammopharmacology)</i> | RCT                                     | Ginger; CRP, TNF- $\alpha$ , IL-6, TAC, SOD, MDA                       | Ginger supplementation significantly decreased CRP, TNF- $\alpha$ , and IL-6 and increased total antioxidant capacity (TAC) and SOD activity. The effects were more pronounced in individuals with chronic metabolic or inflammatory diseases. |
| 7 | Paudel, Orent, & Penela, 2025 | <i>Pharmacological Properties of Ginger (Zingiber officinale): What Do Meta-Analyses Say? A Systematic Review (Frontiers in Pharmacology)</i>                                                                   | Systematic Review                       | Ginger; inflammatory markers, type 2 diabetes, metabolic syndrome      | Reviews show that most meta-analyses reported significant reductions in CRP, hs-CRP, and TNF- $\alpha$ after ginger supplementation, accompanied by improvements in metabolic parameters.                                                      |
| 8 | Ayustanin gwarno et al., 2024 | <i>A Critical Review of Ginger's Antioxidant, Anti-inflammatory and</i>                                                                                                                                         | Narrative Review                        | Gingerol, shogaol, zingerone; NF- $\kappa$ B                           | The active compounds in ginger are able to inhibit                                                                                                                                                                                             |

|    |                         |                                                                                                                                                                                                                                          |                                                           |                                                                                      |                                                                                                                                                                                          |
|----|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                         | <i>Immunomodulatory Activities</i> (Frontiers in Nutrition)                                                                                                                                                                              |                                                           | inflammatory pathway                                                                 | NF-κB activation, reduce the expression of TNF-α, IL-6, and IL-1β, and reduce oxidative stress which plays a role in metabolic diseases.                                                 |
| 9  | Zhang et al., 2024      | <i>Nutritional Components, Phytochemical Compositions, Biological Properties, and Potential Food Applications of Ginger (Zingiber officinale): A Comprehensive Review</i> (Journal of Food Composition and Analysis)                     | Comprehensive Review                                      | Phytochemical components of ginger; biological activities                            | Gingerols and shogaols were identified as the main components contributing to the anti-inflammatory, antioxidant, antidiabetic, and hypolipidemic effects in metabolic disorders.        |
| 10 | Ghoreishi et al., 2024  | <i>The Effects of Ginger (Zingiber Officinale Roscoe) on Non-Alcoholic Fatty Liver Disease in Patients with Type 2 Diabetes Mellitus: A Randomized Double-Blinded Placebo-Controlled Clinical Trial</i> (Journal of Dietary Supplements) | Randomized Double-Blind Placebo-Controlled Clinical Trial | Independent: Ginger;<br>Dependent: NAFLD, metabolic parameters, inflammatory markers | Ginger administration provides improvements in non-alcoholic fatty liver disease parameters in type 2 DM patients and shows potential to reduce inflammation and improve metabolism.     |
| 11 | Schumacher et al., 2024 | <i>The Effect of Oral Supplementation of Ginger on Glycemic Control of Patients with Type 2 Diabetes Mellitus: A Systematic Review and Meta-analysis</i> (Clinical Nutrition ESPEN)                                                      | Systematic Review dan Meta-analysis                       | Ginger; blood glucose, HbA1c, insulin resistance, metabolic parameters               | Meta-analysis showed that ginger supplementation contributed to improved glycemic control and supported a reduction in the risk of inflammation associated with type 2 diabetes.         |
| 12 | Rjabi et al., 2025      | <i>Impact of Ginger Supplementation on Obesity Indices and Adipokine Profiles in Adults: A GRADE-Based Systematic Review and Dose-Response Meta-analysis of Randomized Controlled Trials</i> (Complementary Therapies in Medicine)       | Dose-Response Meta-analysis                               | Ginger; BMI, body weight, adiponectin, leptin                                        | Ginger reduces various obesity indices and improves adipokine profiles. Changes in adiponectin and leptin suggest potential improvements in metabolic inflammation in obese individuals. |
| 13 | Al-Awwadi et al., 2024  | <i>The Effect of Therapeutic Doses of Culinary Spices in Metabolic Syndrome: A Randomized Controlled Trial</i> (Nutrients)                                                                                                               | Double-Blind Randomized Controlled Trial                  | Ginger 3 g/day; blood glucose, HbA1c, lipids, metabolic syndrome                     | Ginger consumption for 12 weeks improved several parameters of metabolic syndrome, including fasting blood glucose,                                                                      |

|    |                                                     |                                                                                                                                                                                                                                             |                                                   |                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    |                                                     |                                                                                                                                                                                                                                             |                                                   |                                                                                                                                            | HbA1c, LDL, and total cholesterol compared to placebo.                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 14 | Rostamkhani H., Veisi P., Niknafs B., et al. (2023) | <i>The Effect of Zingiber officinale on Prooxidant-Antioxidant Balance and Glycemic Control in Diabetic Patients with ESRD Undergoing Hemodialysis: A Double-Blind Randomized Control Trial.</i> (BMC Complementary Medicine and Therapies) | Double-Blind Randomized Placebo-Controlled Trial  | Ginger 2000 mg/day for 8 weeks; Fasting Blood Glucose (FBG), insulin, HOMA-IR, urea, creatinine, and Prooxidant-Antioxidant Balance (PAB). | Ginger supplementation for 8 weeks significantly reduced FBG, HOMA-IR, and urea levels compared to the placebo group. Furthermore, creatinine and PAB levels decreased in the intervention group. The results indicate that ginger can improve glycemic control, increase insulin sensitivity, and improve oxidative status in diabetic patients with ESRD undergoing hemodialysis.                                                                                                        |
| 15 | Rafieipour N., Gharbi N., Rahimi H., et al. (2024)  | <i>Ginger Intervention on Body Weight and Body Composition in Adults: A GRADE-Assessed Systematic Review and Dose-Response Meta-analysis of 27 Randomized Controlled Trials.</i> (Nutrition Reviews)                                        | Systematic Review dan Dose-Response Meta-analysis | Ginger; Body weight, Body Mass Index (BMI), waist circumference (WC), and body fat percentage                                              | Ginger supplementation significantly reduced body weight (WMD = -1.52 kg), BMI (WMD = -0.58 kg/m <sup>2</sup> ), waist circumference (WMD = -1.04 cm), and body fat percentage (WMD = -0.87%). Dose-response analysis showed an effective dose of approximately 2 g/day with an intervention duration of more than 8 weeks. These results indicate that ginger has the potential to improve body composition and risk factors for metabolic diseases associated with chronic inflammation. |

### Effectiveness of Ginger in Reducing Inflammatory Markers in Metabolic Diseases

Based on a synthesis of 15 articles that met the inclusion criteria, most studies showed that ginger (*Zingiber officinale*) supplementation has a positive effect on reducing inflammatory markers in various metabolic diseases, such as type 2 diabetes mellitus, obesity, metabolic syndrome, non-alcoholic fatty liver disease (NAFLD), and diabetes-related end-stage renal disease (ESRD). The inflammatory markers most frequently reported to decrease after ginger

administration were C-reactive protein (CRP), high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-alpha (TNF- $\alpha$ ), and interleukin-6 (IL-6) (Mohammad et al., 2021).

These findings are consistent with studies by Mohammad et al. (2021), Morvaridzadeh et al. (2021), Zhou et al. (2023), and Rjabi et al. (2025), which reported that ginger supplementation significantly reduced CRP, hs-CRP, TNF- $\alpha$ , and IL-6 levels compared to the control group. This reduction in inflammatory markers suggests that ginger has the potential to reduce chronic low-grade inflammation, a key characteristic of various metabolic diseases (Mohammad et al., 2021; Morvaridzadeh et al., 2021; Rjabi et al., 2025).

Chronic inflammation is a key mechanism underlying the development of insulin resistance, adipocyte dysfunction, atherosclerosis, and organ damage in metabolic diseases. Therefore, ginger's ability to reduce inflammatory markers suggests significant therapeutic potential in the management of metabolic diseases.

### **Anti-inflammatory Mechanisms of Ginger in Metabolic Diseases**

The anti-inflammatory effects of ginger are primarily related to its bioactive compounds, namely gingerol, shogaol, paradol, and zingerone. Based on reviews by Ayustaningwarno et al. (2024) and Zhang et al. (2022), these compounds are capable of inhibiting various molecular pathways involved in the inflammatory process (Ayustaningwarno et al., 2024; Zhang et al., 2022).

One key mechanism is inhibition of the activation of Nuclear Factor-kappa B (NF- $\kappa$ B), a transcription factor that plays a role in the expression of various pro-inflammatory genes. NF- $\kappa$ B activation is known to increase the production of TNF- $\alpha$ , IL-1 $\beta$ , IL-6, and various other inflammatory mediators. By inhibiting NF- $\kappa$ B activation, ginger can reduce the production of pro-inflammatory cytokines, thereby reducing systemic inflammation (Ghoreishi et al., 2024).

Furthermore, ginger has also been reported to inhibit the activity of the enzymes cyclooxygenase-2 (COX-2) and lipoxygenase (LOX), which play a role in the formation of inflammatory mediators such as prostaglandins and leukotrienes. Inhibition of this pathway contributes to a reduced chronic inflammatory response in people with metabolic diseases (Ebrahimzadeh et al., 2022).

Shogaols and gingerols are also known to inhibit the activation of the NLRP3 inflammasome, which plays a key role in the production of IL-1 $\beta$  and IL-18. Thus, ginger acts not only at the cytokine level but also on more upstream inflammatory pathways (Paudel et al., 2025)

### **Effect of Ginger on Type 2 Diabetes Mellitus**

Most of the studies analyzed involved patients with type 2 diabetes mellitus. Ebrahimzadeh et al. (2022), Schumacher et al. (2024), Mohammad et al. (2021), and Rostamkhani et al. (2023) showed that ginger supplementation not only reduced inflammatory markers but also improved glycemic control.

These improvements were demonstrated by reduced fasting blood glucose (FBG), HbA1c, insulin, and Homeostatic Model Assessment for Insulin Resistance (HOMA-IR) levels. These results indicate that ginger can improve insulin sensitivity and reduce insulin resistance, which are the primary mechanisms of type 2 diabetes mellitus (Mohammad et al., 2021; Khalilov & Abdullayeva, 2023; Li et al., 2022).

The relationship between inflammation and insulin resistance has been widely reported in the literature. Pro-inflammatory cytokines such as TNF- $\alpha$  and IL-6 can disrupt the insulin signaling pathway through the activation of inflammatory protein kinases (Garg et al., 2023; Engin, 2024). Therefore, reduced inflammatory cytokine levels after ginger administration contribute to improved glucose metabolism (Rostamkhani et al., 2023; Hassanpour et al., 2024; Luo et al., 2022; Wang et al., 2022).

Findings by Rostamkhani et al. (2023) in diabetic patients with ESRD undergoing hemodialysis showed that eight weeks of ginger supplementation significantly reduced FBG and HOMA-IR levels, and improved the prooxidant-antioxidant balance. These results suggest that the benefits of ginger may also be found in populations with more severe metabolic complications (Rostamkhani et al., 2023).

### **The Effect of Ginger on Obesity and Metabolic Syndrome**

Obesity is a metabolic disease closely associated with chronic inflammation. In obesity, macrophage infiltration into adipose tissue leads to increased production of pro-inflammatory cytokines (Rafieipour et al., 2024).

Rafieipour et al. (2024) reported that ginger supplementation significantly reduced body weight, body mass index (BMI), waist circumference, and body fat percentage. These results suggest that ginger has the potential to improve body composition and reduce the risk of metabolic inflammation.

Similar findings were reported by Rjabi et al. (2025), who demonstrated an improvement in the adipokine profile after ginger supplementation. Adipokines such as adiponectin and leptin play an important role in regulating energy metabolism and inflammation. Increased adiponectin and improved adipokine balance may help reduce systemic inflammation in obese individuals (Rjabi et al., 2025).

In patients with metabolic syndrome, a study by Al Dhaheri et al. (2024) showed that ginger consumption for 12 weeks improved fasting blood glucose, HbA1c, LDL, and total cholesterol. Improvements in these factors can reduce the risk of cardiovascular disease, which often accompanies metabolic syndrome.

### **Effect of Ginger on Non-Alcoholic Fatty Liver Disease (NAFLD)**

NAFLD is one of the main manifestations of metabolic disease characterized by fat accumulation in the liver and increased hepatic inflammation. The results of this study indicate that ginger provides significant benefits in NAFLD patients.

Studies by Rahimlou et al. (2026), Zhou et al. (2023), and Ghoreishi et al. (2024) showed that ginger supplementation can reduce inflammatory cytokines, improve insulin resistance, and reduce the degree of hepatic steatosis. These effects are likely due to ginger's ability to reduce oxidative stress and inhibit hepatic inflammation.

Furthermore, the improvements in insulin sensitivity produced by ginger also contribute to reduced fat accumulation in the liver. Therefore, ginger has the potential to be a safe and economical complementary therapy to support the management of NAFLD (Rahimlou et al., 2026; Ghoreishi et al., 2024).

### **Antioxidant Effects of Ginger in Metabolic Diseases**

In addition to its anti-inflammatory effects, ginger also exhibits strong antioxidant activity. Research by Rostamkhani et al. (2023) and Rjabi et al. (2025) showed an increase in total antioxidant capacity (TAC) and superoxide dismutase (SOD) activity, as well as a decrease in malondialdehyde (MDA) and prooxidant-antioxidant balance (PAB) (Rostamkhani et al., 2023; Rjabi et al., 2025).

Oxidative stress is a key mechanism that exacerbates inflammation and insulin resistance in metabolic diseases. The accumulation of reactive oxygen species (ROS) can activate NF- $\kappa$ B and increase the production of proinflammatory cytokines (Schumacher et al., 2024).

By enhancing the body's antioxidant defense system, ginger helps break the cycle between oxidative stress and chronic inflammation. Therefore, ginger's antioxidant and anti-inflammatory effects work synergistically to improve metabolic conditions.

## Conclusion

Based on the results of a synthesis of 15 analyzed articles, it can be concluded that ginger (*Zingiber officinale*) is effective in reducing inflammatory markers in various metabolic diseases, such as type 2 diabetes mellitus, obesity, metabolic syndrome, non-alcoholic fatty liver disease (NAFLD), and diabetes-related end-stage renal disease.

Most studies show that ginger supplementation can reduce levels of key inflammatory markers, namely C-reactive protein (CRP), high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-alpha (TNF- $\alpha$ ), and interleukin-6 (IL-6). This reduction in inflammatory markers indicates that ginger has the potential to reduce chronic low-grade inflammation, a key mechanism in the development of metabolic diseases. The anti-inflammatory effects of ginger are primarily influenced by its bioactive compounds, such as gingerol, shogaol, paradol, and zingerone, which work by inhibiting the Nuclear Factor-kappa B (NF- $\kappa$ B) pathway, reducing proinflammatory cytokine production, and increasing the body's antioxidant activity. In addition to reducing inflammation, ginger supplementation also shows additional benefits such as improved glycemic control, increased insulin sensitivity, improved lipid profiles, weight loss, improved body composition, and increased antioxidant status. The results of this literature review indicate that ginger (*Zingiber officinale*) has the potential to be an effective, safe, and economical complementary therapy to help control inflammation in metabolic diseases. However, further clinical studies with more robust designs, larger sample sizes, and standardized doses and duration of intervention are needed to strengthen the available scientific evidence.

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