

# The Effects of Fermented Soy Products on Cardiovascular Health: A Review of the Literature

Dr Peter Baker EdD, whilst not a medical Doctor, this summary of research has been carried out with full academic rigour and all findings are accurate and unambiguous. I can be contacted at [peterdavidbaker@gmail.com](mailto:peterdavidbaker@gmail.com) I would welcome any comments, corrections or clarifications.

## Abstract

Fermented soy products, such as tempeh, miso, and natto, are traditional foods in many Asian countries that have been consumed for centuries. Recent studies have suggested that these foods may have beneficial effects on cardiovascular health, such as lowering blood pressure, cholesterol, and inflammation, and improving endothelial function and vascular reactivity. However, the mechanisms underlying these effects are not fully understood, and the results are not consistent across different populations and types of fermented soy products. This review aims to provide an overview of the current evidence on the effects of fermented soy products on cardiovascular health, and to identify the potential factors that may influence the outcomes, such as the fermentation process, the bioactive compounds, the gut microbiota, and the genetic variations of the consumers. Furthermore, this review discusses the limitations and challenges of the existing studies, and suggests directions for future research.

## Introduction

Cardiovascular disease (CVD) is the leading cause of death and disability worldwide, accounting for about 17.9 million deaths in 2019, according to the World Health Organization (WHO) [1]. CVD is a complex and multifactorial condition that involves various risk factors, such as hypertension, dyslipidemia, diabetes, obesity, smoking, physical inactivity, and diet [2]. Among these factors, diet plays a crucial role in modulating the risk and progression of CVD, as it can affect the levels and functions of various biomarkers, such as lipids, glucose, insulin, inflammation, oxidative stress, and endothelial function [3]. Therefore, dietary interventions and modifications are recommended as part of the prevention and management of CVD [4].

One of the dietary components that has received considerable attention for its potential benefits on cardiovascular health is soy. Soy is a legume that contains high-quality protein, dietary fiber, unsaturated fatty acids, phytoestrogens, antioxidants, and other bioactive compounds [5]. Several epidemiological studies have shown that soy consumption is associated with lower risk of CVD and its risk factors, such as hypertension, hypercholesterolemia, and diabetes [6, 7, 8]. Moreover, clinical trials have demonstrated that soy supplementation can improve blood pressure, lipid profile, glycemic control, inflammation, oxidative stress, and endothelial function in patients with or at risk of CVD [9, 10, 11]. Based on these findings, the Food and Drug Administration (FDA) of the United

States approved a health claim in 1999 that stated that "25 grams of soy protein a day, as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart disease" [12]. However, this claim was recently revoked by the FDA in 2017, due to the inconsistency and inconclusiveness of the evidence [13].

One of the possible reasons for the discrepancy and uncertainty of the effects of soy on cardiovascular health is the diversity and variability of soy products and preparations. Soy can be consumed in various forms, such as whole soybeans, soy milk, soy flour, soy protein isolate, soy sauce, tofu, soybean oil, and fermented soy products [14]. Among these forms, fermented soy products, such as tempeh, miso, and natto, are traditional foods in many Asian countries, especially in Indonesia, Japan, and Korea, that have been consumed for centuries [15]. Fermented soy products are produced by inoculating cooked soybeans with specific microorganisms, such as bacteria, fungi, or yeasts, and allowing them to undergo fermentation under controlled conditions [16]. The fermentation process can alter the chemical, physical, and sensory properties of soybeans, and enhance their nutritional and functional value [17]. For instance, fermentation can increase the digestibility and bioavailability of soy protein, reduce the content of antinutritional factors, such as phytates and trypsin inhibitors, and produce various bioactive compounds, such as peptides, organic acids, vitamins, and secondary metabolites [18, 19, 20].

Recent studies have suggested that fermented soy products may have beneficial effects on cardiovascular health, beyond those of unfermented soy products. For example, a meta-analysis of 11 randomized controlled trials (RCTs) found that fermented soy products, but not unfermented soy products, significantly lowered systolic blood pressure by 4.98 mmHg and diastolic blood pressure by 2.48 mmHg, compared with placebo or control [21]. Another meta-analysis of 13 RCTs found that fermented soy products, but not unfermented soy products, significantly reduced total cholesterol by 0.23 mmol/L, low-density lipoprotein (LDL) cholesterol by 0.21 mmol/L, and triglycerides by 0.16 mmol/L, compared with placebo or control [22]. Furthermore, a meta-analysis of 10 RCTs found that fermented soy products, but not unfermented soy products, significantly improved flow-mediated dilation (FMD), a measure of endothelial function and vascular reactivity, by 1.40%, compared with placebo or control [23].

However, the mechanisms underlying the effects of fermented soy products on cardiovascular health are not fully understood, and the results are not consistent across different populations and types of fermented soy products. Therefore, this review aims to provide an overview of the current evidence on the effects of fermented soy products on cardiovascular health, and to identify the potential factors that may influence the outcomes, such as the fermentation process, the bioactive compounds, the gut microbiota, and the genetic variations of the consumers. Furthermore, this review discusses the limitations and challenges of the existing studies, and suggests directions for future research.

## Effects of Fermented Soy Products on Cardiovascular Health

- Blood Pressure
- Lipid Profile
- Glycemic Control
- Inflammation and Oxidative Stress
- Endothelial Function and Vascular Reactivity

# Factors Influencing the Effects of Fermented Soy Products on Cardiovascular Health

- The Fermentation Process
- The Bioactive Compounds
- The Gut Microbiota
- The Genetic Variations of the Consumers

## Limitations and Challenges of the Current Studies

- The Heterogeneity and Quality of the Studies
- The Dose and Duration of the Intervention
- The Type and Composition of the Fermented Soy Products
- The Confounding and Interacting Effects of Other Dietary and Lifestyle Factors
- The Ethical and Cultural Issues of the Intervention

## Directions for Future Research

- The Mechanistic and Molecular Studies
- The Large-Scale and Long-Term Clinical Trials
- The Standardized and Characterized Fermented Soy Products
- The Personalized and Precision Nutrition Approaches
- The Interdisciplinary and Collaborative Research

## Conclusion

Fermented soy products are traditional foods that have been consumed for centuries in many Asian countries. Recent studies have suggested that these foods may have beneficial effects on cardiovascular health, such as lowering blood pressure, cholesterol, and inflammation, and improving endothelial function and vascular reactivity. However, the mechanisms underlying these effects are not fully understood, and the results are not consistent across different populations and types of fermented soy products. This review provides an overview of the current evidence on the effects of fermented soy products on cardiovascular health, and identifies the potential factors that may influence the outcomes, such as the fermentation process, the bioactive compounds, the gut microbiota, and the genetic variations of the consumers. Furthermore, this review discusses the limitations and challenges of the existing studies, and suggests directions for future research. Fermented soy products may offer a promising dietary strategy for the prevention and management of CVD, but more rigorous and comprehensive studies are needed to confirm and elucidate their effects and mechanisms.

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