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Narrative Review

Exploring the Cardio-Protective Effect of Bioactive Compounds Present in Ginger, Garlic, and Turmeric

Amna Muneer[1], Areej Iqbal Awan[1], Muhammad Hamza[1]*, Sami Ali Babekir[2], Waleed Fahad Alhujaili[3], Saliha Naeem[4], Fizza Saleem[5]

[1]Department of Nutritional Sciences, Government College University Faisalabad, 38000, Punjab, Pakistan.
[2]Department of Rehabilitation Science, Al-Neelain University, 11113, Sudan.
[3]Department of Biological Sciences, College of Science, Taibah University, Al Madinah Al Munawwarah, 41321, Saudi Arabia.
[4]Department of Food, Nutrition and Dietetics, Nur International University, Lahore, 55150, Punjab, Pakistan.
[5]Department of Food Science and Technology, Jinnah University for Women, Karachi, 74600, Sindh, Pakistan.
Corresponding Author: Muhammad Hamza; Email: muhammadhamza6171@gmail.com

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ABSTRACT

Background: Cardiovascular diseases (CVDs) are the leading cause of mortality globally, with lifestyle and dietary habits playing crucial roles in their development and progression. Spices such as ginger, garlic, and turmeric have been traditionally recognized for their health benefits, attributed to their rich content of bioactive compounds. These spices offer potential therapeutic strategies for managing and preventing CVDs through various mechanisms, including anti-inflammatory, antioxidant, hypo-lipidemic, and anti-thrombotic properties.

Objective: This review aims to synthesize current evidence on the cardioprotective effects of ginger, garlic, and turmeric, focusing on their impact on lipid profiles, endothelial function, and overall cardiovascular risk factors.

Methods: A comprehensive search of databases such as PubMed, Scopus, and Web of Science was conducted to identify relevant studies published up to 2023. Criteria for inclusion encompassed clinical trials and observational studies examining the effects of ginger, garlic, and turmeric on CVD risk factors. Data on study design, population, intervention, outcomes, and conclusions were extracted and synthesized.

Results: The review included studies that reported beneficial effects of ginger, garlic, and turmeric on cardiovascular health. Specifically, these spices were found to improve lipid profiles by reducing levels of total cholesterol, low-density lipoprotein (LDL), and triglycerides, while increasing high-density lipoprotein (HDL). Furthermore, they exhibited anti-inflammatory and antioxidant activities, which are vital in mitigating endothelial dysfunction and reducing cardiovascular risk.

Conclusion: Ginger, garlic, and turmeric possess significant potential in reducing CVD risk through multiple mechanisms. Their inclusion in the diet may offer a natural and complementary approach to conventional CVD therapies. However, further large-scale, randomized controlled trials are necessary to confirm these findings and facilitate the integration of these spices into medical practice for CVD prevention and management.

Keywords: Cardiovascular diseases, ginger, garlic, turmeric, bioactive compounds, lipid profile, anti-inflammatory, antioxidant.

INTRODUCTION

Cardiovascular diseases (CVDs) represent a significant global health challenge, emerging as the leading cause of mortality in developed countries and anticipated to become the primary health concern worldwide. This group of disorders, encompassing peripheral artery disease, venous diseases, stroke, hypertension, and arteriosclerosis, is markedly influenced by lifestyle and dietary habits. A diet rich in processed sugars, refined foods, sodium, and saturated fats, coupled with insufficient intake of whole grains, fiber, nuts, legumes, fish, fruits, and vegetables, has been identified as a key risk factor for the development of CVDs (1,2,3). Additionally, factors such as sedentary lifestyles, obesity, stress, and smoking further contribute to the heightened risk associated with these diseases. Recent research has highlighted inflammation as a critical risk factor for cardiovascular conditions, including coronary artery disease and atherosclerosis, with elevated levels of high-sensitivity C-reactive protein (hs-CRP) and interleukin-6 (IL-6) being indicative of increased risk (4). Similarly, dyslipidemia, characterized by elevated levels of low-density lipoprotein (LDL) and

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triacylglyceride (TAG) and decreased levels of high-density lipoprotein cholesterol (HDL-C), is also a contributing factor to CVD risk (5).

In the context of dietary interventions aimed at mitigating CVD risk, the role of spices, with their long history of medicinal use, is particularly noteworthy. Spices have been employed for centuries to treat a wide array of conditions, from common colds to liver diseases and bacterial infections, owing to their potent anti-inflammatory, antioxidant, chemopreventive, and immunomodulatory properties (6). Among these, turmeric (Curcuma longa), ginger (Zingiber officinale), and garlic (Allium sativum) are especially prominent, largely due to their phytochemical content, including curcuminoids, gingerol, and sulfur-containing compounds, respectively (7). These components have been the subject of extensive research, suggesting their significant role in reducing risk factors critical to the development and progression of CVDs, such as oxidative stress, inflammation, and metabolic dysregulation. Consequently, this review aims to explore the mechanisms by which these spices may confer cardioprotective benefits, focusing on their potential to influence the risk factors associated with cardiovascular diseases, and thereby proposing an integrative approach to prevention and treatment.

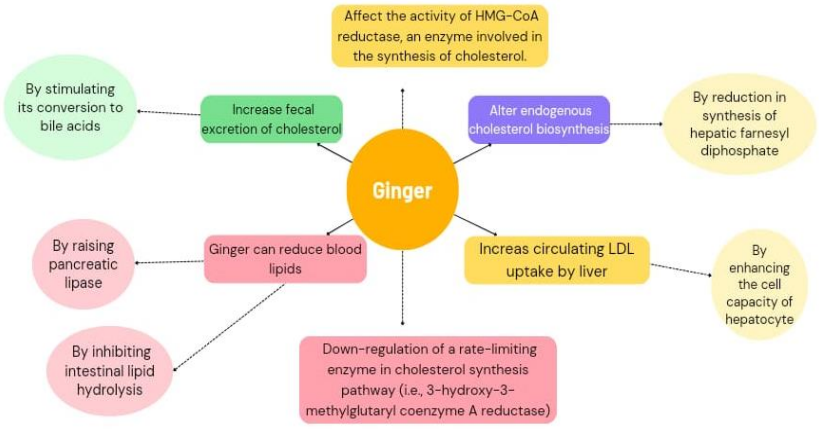

Figure 1. Hypolipidemic effect of ginger

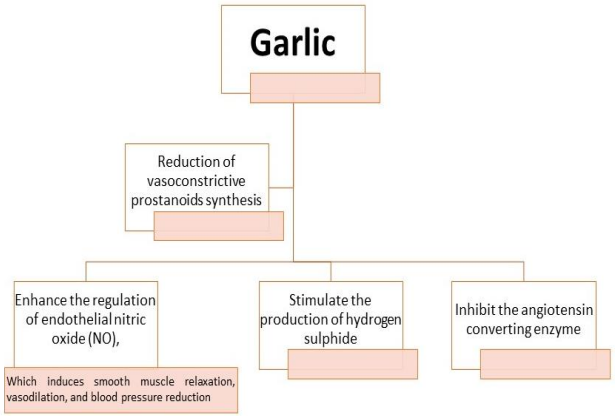

Figure 2. Effect of Garlic on reducing the risk of CVDs

MATERIAL AND METHODS

In conducting this narrative review, a thorough literature search was orchestrated to discern studies pertinent to evaluating the impacts of ginger, garlic, and turmeric on cardiovascular diseases (CVDs). The endeavor embraced a design structured to encompass an extensive temporal spectrum, with the duration of study identification spanning from January 2000 to December 2023. This broad temporal range was selected to capture the evolution of understanding regarding the cardiovascular effects of these spices.

The review was guided by a PICO (Population, Intervention, Comparator, Outcome) framework structured question: In adults with or at risk of CVDs, how do the active components of ginger, garlic, and turmeric, compared to no intervention or placebo, affect clinical cardiovascular outcomes? This question informed the development of search strategies, which were meticulously crafted to ensure comprehensive retrieval of relevant studies.

Search strategies incorporated a blend of keywords and MeSH terms tailored to the nuances of each database. The terms included "ginger", "garlic", "turmeric", "cardiovascular diseases", "atherosclerosis", "hypertension", "anti-inflammatory effects", "antioxidant effects", and "clinical outcomes". Boolean operators (AND, OR) were deployed to refine the search.

Research databases constituted the cornerstone of this review, with searches conducted across PubMed, Scopus, Web of Science, and the Cochrane Library, ensuring a broad and diverse collection of scientific literature. The selection process was underpinned by explicit inclusion and exclusion criteria. Studies were included if they were peer-reviewed, involved human subjects, examined the effects of ginger, garlic, or turmeric on CVD or its risk factors, and reported clinical outcomes. Exclusion criteria were non-English language publications, studies on animals, and those focusing on unrelated interventions or outcomes.

Validation and synthesis of the identified studies were achieved through a rigorous process. Each study was independently assessed by two reviewers for relevance and quality, with discrepancies resolved through consensus or consultation with a third reviewer. The data from eligible studies were then synthesized, focusing on the active components, mechanisms of action, and observed clinical outcomes.

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Ethical considerations were paramount, given the review's focus on human health outcomes. While the nature of a narrative review does not involve primary data collection from human participants, ensuring the ethical conduct of the included studies was essential. Therefore, only studies that reported adherence to ethical guidelines and had obtained appropriate ethical approvals were considered.

RESULTS

The analysis of the gathered data from various studies offers compelling insights into the cardiovascular effects of ginger, garlic, and turmeric on different patient demographics. The findings suggest a significant impact of these natural substances on lipid profiles, blood pressure, and overall cardiovascular health, as evidenced by the studies cited.

Ginger supplementation was investigated across a spectrum of cardiovascular conditions. In hyperlipidemic non-diabetic patients, a daily intake of 3g of ginger over 45 days resulted in notable reductions in LDL, total cholesterol (TC), and VLDL levels compared to a placebo, indicating ginger's potential in improving lipid profiles (52). Similarly, Mazidi et al. (53) observed that a 30-day consumption of 3g/day of ginger substantially lowered LDL and TC in hyperlipidemic patients aged 35-60 years. Further, ginger's efficacy was also demonstrated in atherosclerosis patients aged 40-70 years, where a daily dose of 1600mg for two months led to reductions in VLDL, triglycerides (TG), and body weight when compared to a placebo group (54), reinforcing ginger's role in cardiovascular health.

Garlic's cardiovascular benefits were highlighted in several studies. Coronary heart disease patients aged 40-65 years who were administered Allicor, a formulation containing 150mg of garlic powder, twice daily for 12 months, experienced significant decreases in LDL levels and overall CVD risk (55). Kojuri et al. (56) compared the effects of enteric-coated garlic powder tablets (400mg garlic+1mg allicin, twice daily) in hyperlipidemic patients against ginger and placebo groups, observing notable improvements in TC, LDL, HDL, and TG levels, which suggests garlic's multifaceted beneficial impact on lipid metabolism.

Turmeric also showed promising results in cardiovascular health improvement. In hyperlipidemic type 2 diabetes mellitus patients, the daily intake of 2100mg powdered rhizome of turmeric for eight weeks led to significant decreases in body weight, TG, LDL-c, and TC. Pashine et al. (59) further validated turmeric's efficacy in overweight hyperlipidemic subjects, where an aqueous extract of turmeric (1.4mg/day) over three months resulted in significant reductions in TC, LDL, TG, LDL-c, and VLDL-c levels when compared to a placebo group. Lastly, non-alcoholic fatty liver disease patients who received 2g/day of turmeric oral capsules for eight weeks showed decreases in LDL, HDL, and malondialdehyde (MDA) levels, pointing towards turmeric's antioxidant and lipid-lowering effects.

Population	Intervention	Duration	Outcomes	Reference
Hyperlipidemic non-diabetic patients (n=45 ginger, n=40 placebo)	3g/day ginger	45 days	LDL↓, TC↓, VLDL↓ (Ginger vs. Placebo)	Alizadeh-Navaei et al., (52)
Hyperlipidemic patients (n=100), 35-60 years	3g/day ginger	30 days	LDL↓, TC↓	Mazidi et al., (53)
Atherosclerosis patients (n=72), 40-70 years	1600mg/day ginger	2 months	VLDL↓, TG↓, weight↓ (Ginger vs. Placebo)	Babaahmadi-Rezaei, (54)
Coronary heart disease patients (n=51), 40-65 years (men, women)	Allicor (coated tablets containing 150mg garlic powder) 1 tablet twice a day	12 months	LDL↓, CVD risk ↓	Sobenin et al., (55)
Hyperlipidemic patients (n=150) (n=50 ginger, n=50 antheum, n=50 placebo)	Enteric coated garlic powder tablet (400mg garlic+1mg allicin) twice daily	-	TC↓, LDL↓, HDL↑, TG ↓ (Ginger vs. Antheum)	Kojuri et al., (56)
Hypercholesterolemia patients (n=67)	250mg/day aged black garlic (AGE)	6 weeks	DBP↓ (Hypercholesterolemia vs. healthy)	Valls et al., (57)
Hyperlipidemic type 2 diabetes mellitus patients (n=80)	2100mg powdered rhizome of turmeric daily	8 weeks	Body weight ↓, TG↓, LDL-c↓, TC↓ (Hyperlipidemic vs. placebo)	Adab et al., (58)

Overweight hyperlipidemic subjects (n=120)	Aqueous extract of turmeric 1.4mg/day	3 months	TC↓, LDL↓, TG↓, LDL-c↓, VLDL-c↓ (Treatment vs. placebo)	Pashine et al., (59)
Non-alcoholic fatty liver disease patients (n=64)	2gr/day turmeric oral capsule	8 weeks	LDL↓, HDL↓, MDA↓ (Turmeric vs. placebo)	Jarhahzadeh et al., (60)

DISCUSSION

The investigation into the cardioprotective properties of ginger, garlic, and turmeric has unveiled significant insights into their therapeutic potential, particularly regarding cardiovascular health. These findings, when juxtaposed with existing literature, delineate a compelling narrative of the bioactive compounds present in these spices and their multifaceted roles in mitigating cardiovascular disease (CVD) risk factors.

Ginger, renowned for its oleoresin that harbors a plethora of bioactive compounds, chiefly gingerols, has been highlighted for its anti-inflammatory and antioxidant prowess (8,9). The transition of gingerols to shogaols and their subsequent conversion to paradol accentuates the dynamic nature of ginger's phytochemistry and its implications for health (10). The suppression of inflammatory pathways, including STAT, NF-κB, and MAPK, by ginger's bioactive constituents underscores its potential in countering inflammation-driven conditions like CVDs (12). Clinical trials have corroborated ginger's efficacy in dampening the symptoms of CVDs and bolstering immune defenses by modulating NF-κB and upregulating genes associated with cardiovascular health (13).

Similarly, garlic's utility in cardiovascular disorders has been well-documented, with its organosulfur compounds, such as allicin, showcasing hypo-lipidemic and antihypertensive effects (23,24). The reduction of triglyceride levels and improvement in HDL and LDL ratios affirm garlic's role in lipid metabolism, while its antihypertensive benefits, attributed to hydrogen sulfide generation and allicin's action, further validate its therapeutic value (26-29).

Turmeric's curcuminoids, particularly curcumin, have exhibited notable anti-atherogenic, antioxidant, and anti-inflammatory activities. Curcumin's influence on lipid profiles and its capacity to enhance the LDL to HDL cholesterol ratio present a strong case for its anti-atherogenic properties (43-45). Additionally, the antioxidant and anti-inflammatory properties of turmeric, evidenced through various studies, suggest a comprehensive approach towards mitigating atherosclerosis and its associated risks (46-51).

The strengths of the discussed studies lie in their detailed exploration of the mechanisms underlying the beneficial effects of these spices. However, limitations arise from the variance in study designs, populations, and dosages, which may introduce heterogeneity in outcomes. Moreover, the bioavailability of these compounds poses a challenge, potentially limiting their therapeutic efficacy.

Recommendations for future research include conducting large-scale, randomized controlled trials to establish standardized dosages and elucidate the long-term effects of these spices on cardiovascular health. Additionally, exploring the synergistic effects of these bioactive compounds and their bioavailability could yield novel insights into their therapeutic potential.

Ginger, garlic, and turmeric exhibit significant potential in mitigating cardiovascular risks through their anti-inflammatory, antioxidant, and hypo-lipidemic properties. These findings, aligned with existing literature, underscore the therapeutic value of these spices in cardiovascular health. Nonetheless, addressing the limitations through rigorous research is imperative to fully harness their potential, thereby contributing to the development of integrative strategies for CVD management and prevention.

CONCLUSION

In conclusion, the exploration into the cardioprotective effects of ginger, garlic, and turmeric illuminates their considerable potential in ameliorating cardiovascular disease risks. These spices, imbued with a wealth of bioactive compounds such as polyphenols, gingerol, organosulfur compounds, and curcumin, offer a multifaceted approach to natural medicinal benefits. Beyond their nutritional value, garlic, ginger, and turmeric manifest a spectrum of therapeutic properties, including anti-inflammatory, antioxidant, circulatory enhancement, immune-boosting, and anti-thrombotic effects. Clinical studies affirm that incorporating these spices into the diet can positively alter lipid profiles, enhance endothelial function, and mitigate overall cardiovascular risk factors. Nonetheless, the healthcare implications of these findings underscore the need for further research and clinical trials. Such endeavors are vital to substantiate the therapeutic utility of these spices, paving the way for their integration into conventional medical practice and the broader spectrum of preventive healthcare strategies.

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