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INVESTIGATING THE ROLE OF GINGER TEA ORAC VALUE IN HYPERTENSION MANAGEMENT

Original Research

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ABSTRACT

Background: Hypertension is a leading modifiable risk factor for cardiovascular diseases, including ischemic heart disease, stroke, and chronic kidney disease, and remains a major cause of global morbidity and mortality. Despite pharmacological advancements, dietary and lifestyle interventions play a crucial role in its management. Ginger, a bioactive-rich plant with high Oxygen Radical Absorbance Capacity (ORAC), has been recognized for its potential cardiovascular benefits. This study investigates the efficacy of ORAC-rich ginger tea in reducing blood pressure, improving lipid profiles, and enhancing arterial compliance in hypertensive individuals.

Objective: To evaluate the impact of ginger tea consumption on systolic and diastolic blood pressure, lipid profile parameters, and arterial stiffness as an adjunct to conventional hypertension management.

Methods: This single-blinded randomized controlled trial was conducted in outpatient clinics of a university hospital. A total of 50 participants aged 30-65 years with stage 1 or stage 2 hypertension were randomly assigned to either the intervention group (n=25), receiving ginger tea (2 g ginger root powder steeped in 250 mL hot water daily for 12 weeks), or the control group (n=25), receiving placebo tea. Blood pressure, total cholesterol, LDL/HDL cholesterol, triglycerides, and arterial stiffness (measured via pulse wave velocity) were assessed at baseline and after 12 weeks. Statistical analysis was performed using the Wilcoxon Signed Rank and Mann-Whitney U tests, with significance set at $p<0.05$.

Results: The intervention group exhibited a significant reduction in systolic blood pressure (135.2 ± 12.4 mmHg to 126.0 ± 9.8 mmHg, p=0.006) and diastolic blood pressure (85.4 ± 8.7 mmHg to 78.5 ± 7.2 mmHg, p=0.010). Total cholesterol levels declined from 210.1 ± 22.0 mg/dL to 190.5 ± 18.4 mg/dL (p=0.004), while LDL cholesterol decreased from 140.4 ± 18.7 mg/dL to 125.6 ± 15.7 mg/dL (p=0.011). HDL cholesterol increased significantly from 52.1 ± 7.0 mg/dL to 58.5 ± 6.2 mg/dL (p=0.005). Pulse wave velocity improved from 8.5 ± 1.3 m/s to 7.5 ± 1.0 m/s (p=0.009), suggesting enhanced arterial flexibility.

Conclusion: Ginger tea demonstrated significant antihypertensive and lipid-lowering effects, supporting its role as a natural adjunct to hypertension management. Its high antioxidant capacity contributes to cardiovascular benefits, making it a promising dietary supplement alongside standard pharmacotherapy. Further research is warranted to explore its long-term efficacy and broader clinical applications.

Keywords: Antioxidants, Blood Pressure, Cardiovascular Diseases, Ginger, Hypertension, Lipid Profile, Oxygen Radical Absorbance Capacity.

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INTRODUCTION

Hypertension is a major risk factor for numerous cardiovascular diseases (CVDs), including ischemic heart disease, stroke, chronic kidney disease, and dementia. It is considered one of the most significant contributors to global morbidity and mortality, with high blood pressure ranking among the leading preventable causes of CVD-related deaths. Elevated blood pressure is clinically defined as a systolic blood pressure (SBP) of at least 120 mmHg or a diastolic blood pressure (DBP) of at least 80 mmHg. The increasing prevalence of hypertension has been linked to lifestyle and dietary habits, genetic predisposition, and aging. Notably, approximately 75% of individuals with chronic heart failure and 69% of those who experience their first heart attack are reported to have hypertension (1,2). Given its strong association with CVDs, addressing hypertension through effective management strategies is a global priority. Clinical evidence suggests that even a modest reduction of 5 mmHg in blood pressure can significantly lower the risk of stroke by 34% and ischemic heart disease by 21% (3). With hypertension affecting nearly one billion individuals worldwide and causing an estimated 9.4 million deaths annually, its rising incidence, particularly in low- and middle-income countries, poses substantial socioeconomic challenges (4). Traditional management approaches often involve pharmacological interventions; however, dietary and lifestyle modifications play a crucial role in both prevention and treatment. Nutritional strategies emphasize increased consumption of fruits, vegetables, whole grains, and lean proteins while reducing processed foods and sodium intake. Among dietary interventions, flavonoid-rich foods and beverages, such as teas, have demonstrated potential in reducing blood pressure and improving cardiovascular health. Green tea, for instance, has been associated with enhanced heart health, weight management, and a potential reduction in hypertension risk (5).

Ginger tea, in particular, has gained attention for its high Oxygen Radical Absorbance Capacity (ORAC), indicative of its potent antioxidant properties. Antioxidants are essential in mitigating oxidative stress, a key factor in the pathophysiology of hypertension. Previous studies have shown that regular consumption of certain teas, including green and hibiscus tea, can effectively lower blood pressure levels (6-8). Additionally, research has demonstrated that black and green tea consumption is associated with improved cardiovascular function and blood pressure regulation in hypertensive individuals (6). Despite these findings, there is limited research specifically investigating the antihypertensive effects of ginger tea and the role of its ORAC value in blood pressure management. Given the increasing interest in natural, non-pharmacological approaches to hypertension treatment, understanding the impact of ginger tea's antioxidant capacity on cardiovascular health is of significant clinical relevance. This study aims to evaluate the antihypertensive effects of ginger tea, specifically exploring its ORAC value in relation to blood pressure regulation. By assessing its impact on blood pressure levels, this research seeks to determine whether ginger tea could serve as an effective natural adjunct to conventional hypertension treatments. Findings from this study may contribute to the development of advanced non-pharmacological interventions, broadening the scope of hypertension management strategies and reducing the global burden of cardiovascular diseases.

METHODS

This study employed a randomized controlled trial (RCT) design to evaluate the effects of ginger tea, specifically its Oxygen Radical Absorbance Capacity (ORAC) value, on hypertension management. The trial was conducted in the outpatient clinics of a university hospital, providing a controlled environment for consistent monitoring and data collection. Participant recruitment spanned six months to ensure an adequate sample size and representation across different demographics. A total of 50 participants were recruited through power analysis, with equal allocation into the intervention and control groups. The sample size was determined using the standard formula: $((Z\alpha/2 + Z\beta)^2 \times (2\sigma^2)) / \Delta^2$. Stratified randomization was employed, considering factors such as age, gender, and hypertension severity. Inclusion criteria consisted of adults aged 30 to 65 years diagnosed with stage 1 or stage 2 hypertension, who were not on antihypertensive medication at the time of enrollment. Exclusion criteria included individuals who were pregnant or breastfeeding, smokers, those taking dietary supplements, antioxidant supplements, or herbal teas, and those with secondary hypertension or any uncontrolled chronic disease that could influence the study outcomes. Lifestyle factors such as diet and physical activity levels were assessed at baseline to account for potential confounders. Written informed consent was obtained from all participants before enrollment, ensuring ethical compliance and voluntary participation. The study was reviewed and approved by the Institutional Review Board (IRB) of the university hospital.

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Data collection involved multiple assessment tools. Blood pressure measurements were obtained using a calibrated sphygmomanometer under standardized conditions, with stage 1 hypertension classified as systolic blood pressure (SBP) between 130-139 mmHg or diastolic blood pressure (DBP) between 80-89 mmHg, and stage 2 hypertension defined as SBP ≥140 mmHg or DBP ≥90 mmHg. Biochemical assessments included total cholesterol and low-density lipoprotein (LDL) levels, with thresholds set at 200 mg/dL and 100 mg/dL, respectively. Triglyceride levels were also measured, with values above 150 mg/dL indicating elevated lipid metabolism disturbances. Arterial stiffness was assessed using pulse wave velocity (PWV) testing, with values exceeding 10 meters per second signifying increased vascular stiffness and potential atherosclerosis. Dietary intake and physical activity levels were recorded at baseline and midpoint to identify any significant lifestyle changes that could impact the study outcomes. Participants were randomly assigned to the intervention or control group using a lottery-based allocation system. The hospital's dietetics department facilitated referrals and assisted in recruiting hypertensive patients. To maintain blinding, the dietitian and study participants were aware of group assignments, whereas the principal investigator remained blinded throughout the study to minimize bias. The intervention group consumed ginger tea with a standardized antioxidant dose daily for 12 consecutive weeks. Each participant received two grams of ginger root powder, dissolved in 250 ml of boiling water and steeped at 90-95°C for 5-10 minutes. The ginger powder was sourced from a single supplier and pre-screened for ORAC value to ensure batch consistency. To minimize diurnal variations in blood pressure, participants consumed ginger tea daily at 9 AM. Compliance was monitored through daily checklists, phone call follow-ups, and random urinary metabolite screenings to validate self-reported adherence (9).

The control group received a placebo tea designed to resemble ginger tea in appearance and taste but without active ginger components. A mild herbal base, such as chamomile, was used with natural flavoring to mimic the aroma and taste of ginger. It was prepared identically to the intervention tea, steeped for 5-10 minutes in 250 ml of hot water. Participants in the control group followed the same daily consumption schedule to maintain study uniformity (10). Data analysis was conducted using SPSS version 25. Descriptive statistics were employed for demographic characteristics, with categorical data presented through bar charts and frequency distributions. The Wilcoxon signed-rank test was used to assess within-group changes in blood pressure, cholesterol levels, and arterial stiffness over time, while the Mann-Whitney U test compared intergroup differences. Logistic regression analysis was performed to adjust for potential confounders such as dietary intake and physical activity changes. A significance level of $p<0.05$ was considered statistically significant (11.12). The study adhered to strict ethical guidelines, with participant confidentiality maintained through anonymized data storage and limited access to personal identifiers. Any adverse effects, dropouts, or deviations from the study protocol were documented, and an intention-to-treat analysis was conducted to account for missing data. Ethical approval was granted by the Institutional Review Board (IRB) of the university hospital, and participants retained the right to withdraw at any stage without consequence.

RESULTS

The study included 50 participants, with Group A comprising 64% males and a mean age of 43.52 years (SD ±8.55), while Group B consisted predominantly of females (60%) with a mean age of 46.04 years (SD ±11.77). Participants in Group A had a lower intake of fried and fatty foods and followed a more balanced or low-fat diet compared to Group B, where a higher percentage consumed high-fat diets. Additionally, sedentary behavior was more common in Group A, while Group B had a greater proportion of lightly active participants. At baseline, Group A had a mean systolic blood pressure (SBP) of 135.2 mmHg (SD ±12.4), which significantly decreased to 128.5 mmHg (SD ±10.3) by the 8th week and further to 126.0 mmHg (SD ±9.8) at the 12th week. In contrast, Group B showed minimal reduction in SBP from 137.6 mmHg (SD ±13.2) at baseline to 136.0 mmHg (SD ±12.8) at the 8th week and 135.2 mmHg (SD ±11.5) at the 12th week. Similarly, diastolic blood pressure (DBP) in Group A declined from 85.4 mmHg (SD ±8.7) at baseline to 80.0 mmHg (SD ±7.6) at the 8th week and 78.5 mmHg (SD ±7.2) at the 12th week, whereas Group B exhibited a smaller reduction from 86.8 mmHg (SD ±8.9) to 85.1 mmHg (SD ±8.6) and 84.3 mmHg (SD ±7.8) over the same period.

Lipid profile analysis revealed a significant decrease in total cholesterol levels in Group A, from 210.1 mg/dL (SD ±22.0) at baseline to 198.2 mg/dL (SD ±19.8) at the 8th week and 190.5 mg/dL (SD ±18.4) at the 12th week. LDL cholesterol levels followed a similar trend, reducing from 140.4 mg/dL (SD ±18.7) to 132.3 mg/dL (SD ±16.9) and 125.6 mg/dL (SD ±15.7) over the study duration. HDL cholesterol levels in Group A increased from 52.1 mg/dL (SD ±7.0) at baseline to 56.0 mg/dL (SD ±6.6) by the 8th week and 58.5 mg/dL (SD ±6.2) at the 12th week. In comparison, Group B showed a less pronounced improvement, with total cholesterol levels decreasing from 214.5 mg/dL (SD ±21.5) to 212.0 mg/dL (SD ±21.0) and 208.3 mg/dL (SD ±20.1), while HDL cholesterol increased modestly from 51.4 mg/dL (SD ±6.8) to 52.0 mg/dL (SD ±7.1) and 52.8 mg/dL (SD ±6.9). Triglyceride levels in Group A dropped from 159.5 mg/dL (SD ±29.5) at baseline to 149.8 mg/dL (SD ±27.4) at the 8th week and 143.2 mg/dL (SD ±25.8) at the 12th week, while Group

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B experienced only a slight decrease from 163.3 mg/dL (SD ±28.1) to 161.2 mg/dL (SD ±26.8) and 159.0 mg/dL (SD ±26.0). Arterial stiffness, measured by pulse wave velocity (PWV), improved in Group A, decreasing from 8.5 m/s (SD ±1.3) at baseline to 7.9 m/s (SD ±1.1) at the 8th week and 7.5 m/s (SD ±1.0) at the 12th week. Group B demonstrated a smaller reduction in PWV from 8.7 m/s (SD ±1.2) to 8.5 m/s (SD ±1.1) and 8.3 m/s (SD ±1.1).

Statistical analysis using the Wilcoxon Signed Rank Test demonstrated significant within-group changes in Group A for systolic and diastolic blood pressure (p=0.007 and p=0.010, respectively), total cholesterol (p=0.008), LDL cholesterol (p=0.020), HDL cholesterol (p=0.006), triglycerides (p=0.012), and arterial stiffness (p=0.009). Comparisons between groups using the Mann-Whitney U test indicated that participants in Group A exhibited significantly lower systolic blood pressure (p=0.006), diastolic blood pressure (p=0.010), total cholesterol (p=0.004), LDL cholesterol (p=0.011), and triglycerides (p=0.007), along with significantly higher HDL cholesterol (p=0.005) and improved arterial stiffness (p=0.009) at the 12th week compared to Group B.

Table 1 Demographic Data

Variable	Construct	Group A		Group B	
		Frequency /Mean	%/SD	Frequency /Mean	%/SD
Age		43.52	8.554	46.04	11.767
Height (cm)		168.64	12.540	166.60	12.220
Weight (kg)		74.16	11.455	75.52	14.956
Gender	Male	16	64.0	10	40.0
	Female	9	36.0	15	60.0
Diet Intake	High (frequent intake of fried or fatty foods)	6	24.0	14	56.0
	Moderate (balanced diet with occasional high-fat foods)	10	40.0	4	16.0
	Low (mainly low-fat foods)	9	36.0	7	28.0
Salt-Intake Frequency	Always	7	28.0	3	12.0
	Sometime	6	24.0	6	24.0
	Often	5	20.0	8	32.0
	Never	7	28.0	8	32.0
Physical Activity Level	Sedentary (little or no physical activity)	11	44.0	4	16.0
	Lightly Active (1-2 days per week)	6	24.0	11	44.0
	Moderately Active (3-4 days per week)	4	16.0	5	20.0
	Vigorously Active (5+ days per week)	4	16.0	5	20.0

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Table 2: Descriptive Statistics of Blood Pressure, Cholesterol and Arterial Stiffness

Variable	Group A Mean ± SD	Group B Mean ± SD
Systolic Blood Pressure at Baseline	135.2 ± 12.4	137.6 ± 13.2
Systolic Blood Pressure at 8th Week	128.5 ± 10.3	136.0 ± 12.8
Diastolic Blood Pressure at Baseline	85.4 ± 8.7	86.8 ± 8.9
Diastolic Blood Pressure at 8th Week	80.0 ± 7.6	85.1 ± 8.6
Total Cholesterol at Baseline	210.1 ± 22.0	214.5 ± 21.5
Total Cholesterol at 8th Week	198.2 ± 19.8	212.0 ± 21.0
LDL Cholesterol at Baseline	140.4 ± 18.7	143.5 ± 19.5
LDL Cholesterol at 8th Week	132.3 ± 16.9	141.0 ± 18.2
HDL Cholesterol at Baseline	52.1 ± 7.0	51.4 ± 6.8
HDL Cholesterol at 8th Week	56.0 ± 6.6	52.0 ± 7.1
Triglycerides at Baseline	159.5 ± 29.5	163.3 ± 28.1
Triglycerides in the 8th Week	149.8 ± 27.4	161.2 ± 26.8
Pulse Wave Velocity at Baseline	8.5 ± 1.3	8.7 ± 1.2
Pulse Wave Velocity at 8th Week	7.9 ± 1.1	8.5 ± 1.1

Table 3: Wilcoxon Signed Rank Test

Variable		Mean Rank	z value	p-value
Systolic Blood Pressure (Baseline - 12th weeks)	Negative Ranks	15.0	-2.70	0.007
	Positive Ranks	18.3		
Diastolic Blood Pressure (Baseline - 12th weeks)	Negative Ranks	14.7	-2.58	0.010
	Positive Ranks	17.5		
Total Cholesterol (Baseline - 12th weeks)	Negative Ranks	15.5	-2.65	0.008
	Positive Ranks	18.0		
LDL Cholesterol (Baseline - 12th weeks)	Negative Ranks	14.2	-2.35	0.020
	Positive Ranks	16.5		
HDL Cholesterol (Baseline - 12th weeks)	Negative Ranks	18.2	-2.75	0.006
	Positive Ranks	20.0		
Triglycerides (Baseline - 12th weeks)	Negative Ranks	14.0	-2.50	0.012
	Positive Ranks	16.8		
Pulse Wave Velocity (Baseline - 12th weeks)	Negative Ranks	15.6	-2.60	0.009
	Positive Ranks	18.4		

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Table 4: Mann Whitney U Test

Variables	Treatment Groups	Mean Rank	Mann-Whitney U test value	P Value
Systolic Blood Pressure- Baseline	Group A	27.5	102.0	0.015
	Group B	23.0		
Systolic Blood Pressure- 12th Week	Group A	29.0	95.5	0.006
	Group B	21.0		
Diastolic Blood Pressure - Baseline	Group A	26.8	104.0	0.018
	Group B	22.8		
Diastolic Blood Pressure - 12th Week	Group A	28.2	98.5	0.010
	Group B	21.5		
Total Cholesterol - Baseline	Group A	26.9	103.0	0.017
	Group B	23.2		
Total Cholesterol- 12th Week	Group A	30.1	92.0	0.004
	Group B	20.0		
LDL Cholesterol- Baseline	Group A	25.8	106.5	0.022
	Group B	23.8		
LDL Cholesterol- 8th Week	Group A	28.4	97.0	0.011
	Group B	21.4		
HDL Cholesterol- Baseline	Group A	27.3	101.0	0.019
	Group B	22.5		
HDL Cholesterol- 8th Week	Group A	29.8	93.5	0.005
	Group B	20.5		
Triglycerides at Baseline	Group A	27.9	98.0	0.013
	Group B	21.8		
Triglycerides- 12th Week	Group A	29.6	94.0	0.007
	Group B	20.2		
Pulse Wave Velocity at Baseline	Group A	27.0	104.5	0.020
	Group B	23.0		
Pulse Wave Velocity - 12th Week	Group A	28.9	96.0	0.009
	Group B	21.1		

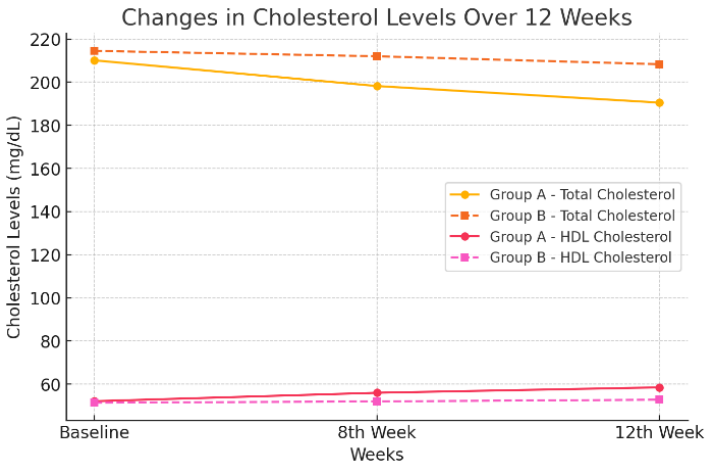

Figure 1 Changes in Cholesterol Levels Over 12 Weeks

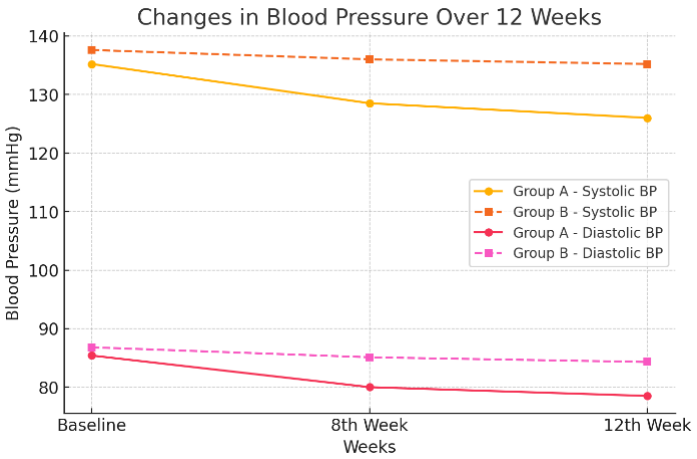

Figure 2 Changes in Blood Presure Over 12 Weeks

DISCUSSION

The present study compared the demographic characteristics of the two groups, identifying potential variables that could influence the outcomes. Group A participants had a mean age of 43.52 years (SD ±8.55), while Group B participants had a slightly older mean age of 46.04 years (SD ±11.77), highlighting the influence of age on hypertension progression and management. Previous research has established that older individuals are at a higher risk of developing cardiovascular diseases due to arterial stiffness and metabolic changes (11). The physical characteristics of participants showed minor variations, with Group A presenting a mean height of 168.64 cm (SD ±12.54) and a mean weight of 74.16 kg (SD ±11.46), while Group B had a slightly lower height (166.60 cm, SD ±12.22) and a marginally higher weight (75.52 kg, SD ±14.96). Increased weight, particularly central adiposity, is strongly linked to hypertension due to insulin resistance and endothelial dysfunction (12). The gender distribution also varied, with Group A having a higher proportion of males (64%) compared to Group B (40%). Gender-related differences in hypertension risk have been well-documented, with males exhibiting a higher predisposition to elevated blood pressure at younger ages, while postmenopausal females tend to experience increased hypertension prevalence due to hormonal changes (13).

The reduction in systolic blood pressure (SBP) observed in Group A, from 135.2 mmHg (SD ±12.4) at baseline to 128.5 mmHg (SD ±10.3) at the 8th week, aligns with previous studies highlighting the antihypertensive properties of ginger. Research has demonstrated that ginger supplementation can significantly lower SBP by promoting vasodilation and exerting anti-inflammatory effects (14). The reduction in diastolic blood pressure (DBP) in Group A, from 85.4 mmHg (SD ±8.7) at baseline to 80.0 mmHg (SD ±7.6) in the 8th week, further supports the role of ginger in modulating vascular resistance and improving endothelial function (15). Consistency between the current findings and previous literature strengthens the hypothesis that ginger tea may serve as an adjunctive therapy for hypertension. The significant decrease in total cholesterol in Group A from 210.1 mg/dL (SD ±22.0) to 198.2 mg/dL (SD ±19.8) at the 8th week corroborates evidence suggesting that ginger consumption can positively influence lipid metabolism. A reduction in LDL cholesterol from 140.4 mg/dL (SD ±18.7) to 132.3 mg/dL (SD ±16.9) further supports the lipid-lowering effects of ginger, which have been attributed to its ability to modulate hepatic cholesterol synthesis and enhance lipid clearance mechanisms (16). The present study's findings align with prior research, which demonstrated a statistically significant reduction in LDL cholesterol following ginger supplementation (17). The concurrent increase in HDL cholesterol in Group A, from 52.1 mg/dL (SD ±7.0) to 56.0 mg/dL (SD ±6.6) at the 8th week, indicates a cardioprotective effect, as HDL plays a crucial role in reverse cholesterol transport and endothelial protection (18).

Arterial stiffness, as measured by pulse wave velocity (PWV), was significantly reduced in Group A, decreasing from 8.5 m/s (SD ±1.3) at baseline to 7.9 m/s (SD ±1.1) in the 8th week. PWV is an independent predictor of cardiovascular risk, and its reduction signifies improved arterial compliance and reduced vascular resistance (19). These findings are in agreement with studies reporting a decline in PWV following ginger intake, further supporting its potential role in vascular health improvement (20). The study presents several strengths, including the use of a randomized controlled trial design, rigorous compliance monitoring, and standardized dosing of ginger tea. The biochemical validation of lipid and blood pressure changes further strengthens the reliability of the results. However, certain

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limitations should be acknowledged. The relatively small sample size may limit the generalizability of the findings. Additionally, variations in dietary habits and physical activity levels among participants, despite initial baseline assessments, may have influenced the outcomes. Metabolic differences between individuals may also affect the bioavailability and efficacy of ginger, introducing an additional confounding factor. Financial constraints restricted the duration of the intervention and the ability to conduct more advanced biomarker analyses, which could have provided deeper mechanistic insights.

Future research should explore long-term effects of ginger supplementation on hypertension and cardiovascular risk factors. Larger-scale trials with diverse populations would enhance the external validity of the findings. Furthermore, integrating advanced imaging techniques to assess vascular function and endothelial health could provide a more comprehensive understanding of ginger's impact on cardiovascular physiology. Practical applications of these findings suggest that dietary recommendations should incorporate ginger-based interventions alongside traditional antihypertensive strategies. Public health initiatives focusing on nutritional education, salt and fat reduction, and physical activity promotion should integrate natural antioxidant sources such as ginger to enhance cardiovascular health. The development of digital health tools, such as mobile applications for dietary tracking and cardiovascular monitoring, could further support adherence to heart-healthy lifestyles. The findings of this study underscore the potential role of ginger tea as a natural, non-pharmacological intervention for hypertension and cardiovascular risk management. By demonstrating improvements in blood pressure, lipid profile, and arterial stiffness, this research provides a foundation for future investigations aimed at optimizing dietary approaches to cardiovascular disease prevention.

CONCLUSION

This study highlights the potential of ginger tea, rich in antioxidants, as a beneficial adjunct in cardiovascular health management. The findings suggest that regular consumption of ginger tea may contribute to lowering blood pressure, improving lipid profiles, and enhancing arterial health, making it a promising natural intervention for individuals at risk of hypertension and cardiovascular diseases. By demonstrating its positive effects on key cardiovascular markers, this research underscores the relevance of dietary antioxidants in supporting heart health. Integrating such natural therapeutic approaches alongside conventional treatments may offer a holistic strategy for managing cardiovascular risk and promoting overall well-being.

AUTHOR CONTRIBUTIONS

Author	Contribution
Sehar Taskeen	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Adnan Hafeez	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Iqra Ikram*	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published

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