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A SYSTEMATIC REVIEW ON EFFECTIVENESS OF BEET ROOTS JUICE IN LOWERING BLOOD PRESSURE AMONG PRE-HYPERTENSIVE INDIVIDUALS

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ABSTRACT

Pre-hypertension is an early stage of high blood pressure that can increase the risk of heart disease and future hypertension. Regular consumption of beetroot juice may contribute to the reduction of blood pressure due to its high concentration of naturally source of dietary nitrates. These nitrates are converted into nitric oxide within the body, a molecule that promotes vasodilatation, enhances blood circulation, and reduces vascular resistance. Incorporating beetroot juice into the daily diet represents a simple, cost-effective, and food-based strategy that may support the prevention and management of elevated blood pressure, particularly among individuals with pre-hypertension. As interest in non-pharmacological approaches to cardiovascular disease prevention continues to grow, dietary interventions have gained considerable attention. Among these, beetroot juice has emerged as a promising functional food because of its potential to improve endothelial function, enhance vascular health, and reduce the risk of hypertension-related cardiovascular complications.

Keywords: **Beetroot juice, pre-hypertension, blood pressure, dietary nitrate, nitric oxide, endothelial function, cardiovascular health, functional food, non-pharmacological intervention**

INTRODUCTION

High blood pressure (hypertension) is one of the most common health problems across the world. It is a major risk factor for heart disease, stroke, kidney disease, and other cardiovascular conditions. Before developing hypertension, many people pass through a stage called pre-hypertension. In this stage, the systolic blood pressure ranges from 120–139 mmHg and the diastolic blood pressure ranges from 80–89 mmHg. Although blood pressure is not yet in the hypertensive range, people with pre-hypertension are more likely to develop high blood pressure in the future if proper preventive measures are not taken **[1]**.

Because of this increased risk, early prevention is very important. Simple lifestyle changes such as regular physical activity, maintaining a healthy body weight, reducing stress, limiting salt intake, avoiding smoking, and eating a healthy diet can help control blood pressure and reduce the chances of developing hypertension **[2]**. These changes are safe, affordable, and can be followed by most people as part of their daily routine.

In recent years, researchers have shown growing interest in the role of food in preventing and managing high blood pressure. Among different natural foods, beetroot has received considerable attention because it is rich in dietary nitrate. After drinking beetroot juice, the nitrate is converted into nitrite and then into nitric oxide in the body. Nitric oxide helps for vasodilatation, allowing blood to flow more easily. This improves blood circulation and may help to reduce blood pressure naturally **[3]**.

Beetroot juice also contains antioxidants, vitamins, minerals, and other plant compounds that support heart and blood vessel health. Because it is easy to prepare, inexpensive, and naturally available, beetroot juice may be a practical dietary option for people with pre-hypertension. Many recent studies have examined its effect on blood pressure, but the findings are not always consistent **[4]**. Therefore, reviewing the available evidence is important to understand whether regular consumption of beetroot juice can effectively lower blood pressure in pre-hypertensive individuals and support its use as a simple lifestyle intervention.

METHODOLOGY

This systematic review was carried out following the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The main purpose of this review was to examine the available evidence on the effectiveness of beetroot juice supplementation in reducing blood pressure among individuals with pre-hypertension. A comprehensive literature search was performed across the following

electronic databases: PubMed/MEDLINE, Scopus, WebScience, Embase, CINAHL Studies published between January 2010 and December 2025 were searched.

SEARCH STRATEGY

- The literature search was carried out using the following keywords: "beetroot juice," "dietary nitrate," "prehypertension," "elevated blood pressure," "blood pressure," "hypertension," "randomized controlled trial," and "clinical trial."
- Boolean operators such as AND, OR were used to combine search terms and improve the accuracy and relevance of the search results.
- Inclusion Criteria:
- Studies involving adults aged 18 years and above.
- Participants diagnosed with prehypertension or elevated blood pressure.
- Research evaluating the effects of beetroot juice supplementation on blood pressure.
- Exclusion Criteria:
- Studies in which beetroot juice was given together with pharmacological interventions, making it difficult to assess its independent effect.
- Studies that did not report blood pressure as an outcome measure.

Mechanism of Action of Beetroot Juice:

Beetroot is a rich natural source of dietary nitrate, which plays an important role in regulating blood pressure. After consumption, dietary nitrate is absorbed and concentrated in the salivary glands, where oral bacteria convert it into nitrite **[5]**. Once swallowed, nitrite is further reduced to nitric oxide (NO) in the blood and tissues, particularly under low-oxygen conditions. This nitrate–nitrite–nitric oxide pathway provides an alternative source of nitric oxide that supports cardiovascular function **[6]**.

Nitric oxide is a key molecule which involved in maintaining vascular health. It promotes relaxation of vascular smooth muscle by activating the cyclic guanosine monophosphate (cGMP) pathway that will resulting in vasodilatation. The widening of blood vessels decreases peripheral vascular resistance, thereby lowering arterial blood pressure. In addition, nitric oxide improves endothelial function, increases arterial flexibility, and enhances tissue blood flow, all of which contribute to better cardiovascular performance **[7]**.

Beyond its vasodilatory effects, nitric oxide exerts several protective actions within the cardiovascular system. It inhibits platelet aggregation, reduces oxidative stress, and suppresses inflammatory processes in the vascular wall. These effects help preserve endothelial integrity and may reduce the risk

of hypertension and the development of atherosclerosis **[8]**.

Evidence from clinical studies suggests that regular beetroot juice supplementation can improve endothelial function, particularly in individuals with pre-hypertension or elevated blood pressure. Improved endothelial function enhances the ability of blood vessels to regulate vascular tone and maintain normal blood pressure. Collectively, these mechanisms support the potential role of beetroot juice as a simple, non-pharmacological dietary intervention for blood pressure management and cardiovascular risk reduction.

REVIEW OF LITERATURE

Recent research has increasingly focused on dietary approaches for the prevention and management of elevated blood pressure, particularly during the pre-hypertensive stage. Among the various nutritional interventions, beetroot juice has received considerable attention because of its high dietary nitrate content and its potential to improve cardiovascular health through non-pharmacological means. This interest is driven by the need for safe, cost-effective, and easily accessible strategies to reduce the growing burden of hypertension **[9, 10]**.

Beetroot juice is recognized as a rich source of inorganic nitrate, which is converted into nitrite by subsequently into nitric oxide within the body. Nitric oxide is an important molecule that promotes vasodilatation, improves endothelial function, and reduces peripheral vascular resistance. These physiological effects contribute to improved vascular function and a reduction in both systolic and diastolic blood pressure. The nitrate–nitrite–nitric oxide pathway has therefore become an important area of investigation in cardiovascular research **[11]**.

Several randomized controlled trials, clinical studies, and systematic reviews have examined the effects of beetroot juice supplementation on blood pressure in healthy adults, individuals with pre-hypertension, and patients with hypertension. The majority of these studies have reported significant reductions in systolic blood pressure, while improvements in diastolic blood pressure have also been observed in many cases. The magnitude of these effects appears to depend on factors such as the nitrate concentration of the beetroot juice, the duration of supplementation, participants' baseline blood pressure, and adherence to the intervention.

The literature also highlights the importance of combining nutritional interventions with healthy lifestyle practices, including regular physical activity, weight management, reduced sodium intake, and increased consumption of fruits and vegetables. Such comprehensive approaches are considered effective in delaying or preventing the

progression from pre-hypertension to established hypertension. Within this context, beetroot juice may serve as a valuable dietary supplement that complements existing lifestyle modification strategies.

Although the current body of evidence supports the beneficial effects of beetroot juice on blood pressure and vascular function, several research gaps remain. Variations in study design, sample size, nitrate dosage, intervention duration, and participant characteristics have resulted in inconsistent findings across some studies. Consequently, further large-scale, well-designed randomized controlled trials with longer follow-up periods are needed to establish the optimal dosage, duration of supplementation, long-term safety, and effectiveness of beetroot juice in diverse populations.

Overall, the available literature suggests that beetroot juice is a promising dietary intervention for improving vascular health and lowering blood pressure, particularly among individuals with pre-hypertension. Its favorable safety profile, easy for consumption, and potential cardiovascular benefits support its inclusion as part of a comprehensive strategy for the prevention and management of hypertension.

1.Evidence from Clinical Studies

- **Kapil *et al*. (2015)** One of the landmark randomized controlled trials demonstrated that daily consumption of nitrate-rich beetroot juice significantly reduced systolic blood pressure in hypertensive individuals. Improvements in endothelial function and arterial stiffness were also observed. The study highlighted the potential of dietary nitrate as an adjunct treatment for blood pressure management **[12]**.
- **Siervo *et al*. (2020)** A double-blind randomized controlled trial among adults with elevated blood pressure found that supplementation with nitrate-rich beetroot juice for 60 days reduced 24-hour ambulatory systolic blood pressure by approximately 6–11 mmHg. These findings support the long-term effectiveness of beetroot juice in blood pressure reduction **[13]**.
- **2. Studies in Pre-Hypertensive Adults**

  Several randomized trials included healthy and pre-hypertensive adults and reported reductions in systolic blood pressure ranging from 3 to 10 mmHg following short-term beetroot juice supplementation. The effects were more pronounced in individuals with higher baseline blood pressure levels **[14]**.
- **Coles and Clifton (2012)** performed a randomized placebo-controlled crossover trial among free-living healthy adults with elevated blood pressure levels. Participants who consumed

beetroot juice showed a measurable reduction in systolic blood pressure within six hours of intake. The study concluded that beetroot juice consumed as part of a normal diet could significantly lower blood pressure and reduce cardiovascular risk among individuals with borderline hypertension **[15]**.

- **Asgary *et al.* (2016)** performed a randomized crossover pilot study to assess the effects of red beetroot juice supplementation on hypertension, endothelial function, and systemic inflammation among adults with elevated blood pressure. The study reported significant improvements in endothelial function and reductions in blood pressure after short-term beetroot juice supplementation. The authors emphasized the cardioprotective and anti-inflammatory properties of beetroot juice in individuals at risk of hypertension **[16]**.

3. Evidence from Systematic Reviews and Meta-Analyses:

- **Siervo *et al.* (2013)** Conducted one of the earliest systematic reviews and meta-analyses assessing the effects of inorganic nitrate and beetroot juice supplementation on blood pressure in adults. The review included randomized controlled trials involving healthy and hypertensive participants. The findings demonstrated significant reductions in systolic blood pressure following nitrate supplementation, suggesting that dietary nitrate from beetroot juice may serve as an effective non-pharmacological intervention for cardiovascular risk reduction **[17]**.
- **Bahadoran *et al.* (2017)** performed a comprehensive systematic review and meta-analysis involving 22 randomized clinical trials conducted between 2009 and 2017. The review included 47 intervention groups and 43 control groups with a total of more than 1,200 participants. The study reported that beetroot juice supplementation significantly reduced systolic blood pressure by approximately 3.55 mmHg and diastolic blood pressure by approximately 1.32 mmHg. Greater reductions were observed with higher doses and intervention durations longer than 14 days. The authors concluded that beetroot juice possesses clinically significant blood pressure-lowering effects and may also exert nitrate-independent cardiovascular benefits **[19]**.
- **Jackson *et al.* (2018)** conducted a systematic review and meta-analysis on the role of inorganic nitrate and nitrite in cardiovascular disease risk factors. The findings showed that dietary nitrate supplementation improved vascular

function and significantly lowered systolic blood pressure among adults with elevated cardiovascular risk **[19]**.

- **Bonilla-Ocampo *et al*. (2018)** This systematic review examined randomized controlled trials from 2008–2018 and found consistent evidence supporting beetroot juice as a cost-effective nutritional strategy for reducing blood pressure in healthy, pre-hypertensive, and hypertensive populations. The authors emphasized the role of the nitrate–nitrite–nitric oxide pathway in mediating these effects **[20]**.
- **Mahida and Sarate (2020)** conducted a study in the central region of Gujarat to evaluate the effectiveness of beetroot juice in reducing blood pressure among post-menopausal women with elevated blood pressure. The study reported significant reductions in blood pressure levels after beetroot juice supplementation. The authors emphasized that beetroot juice may be beneficial in reducing cardiovascular risk among women with elevated blood pressure in the Indian population **[21]**.
- **Benjamim *et al*. (2022)** A meta-analysis of seven randomized controlled trials involving hypertensive adults found that nitrate-rich beetroot juice significantly reduced systolic blood pressure by approximately **4.95 mmHg** compared with controls. Although diastolic blood pressure reduction was not statistically significant, the findings support the clinical relevance of beetroot juice in blood pressure management **[22]**.
- **Grönroos *et al*. (2024)** A recent systematic review and meta-analysis evaluated the effects of beetroot juice according to European Society of Hypertension guidelines. The review demonstrated that beetroot juice significantly lowered clinical systolic blood pressure, especially during interventions lasting up to 90 days. However, evidence for prolonged 24-hour blood pressure reduction remained limited. The authors recommended further large-scale trials to establish long-term efficacy and standardized supplementation protocols **[23]**.
- **Padmapriya *et al*. (2024)** conducted a single-centre interventional study at Saveetha College of Nursing, Chennai, Tamil Nadu, to assess the efficacy of beetroot juice supplementation on blood pressure among hypertensive patients. The findings revealed a significant reduction in systolic and diastolic blood pressure following regular beetroot juice supplementation. The researchers concluded that beetroot juice could be considered an effective complementary dietary intervention for blood pressure management among Indian patients **[24]**.

- Recent Indian health reports and nutritional studies have further emphasized the cardiovascular benefits of beetroot juice. Evidence suggests that daily intake of approximately 200–250 mL of nitrate-rich beetroot juice may help reduce systolic and diastolic blood pressure and improve vascular health. Researchers also recommend moderate consumption because excessive intake may increase oxalate exposure and the risk of kidney stones in susceptible individuals **[23]**.

4. Relevance to Pre-Hypertensive Individuals:

Pre-hypertensive individuals represent an ideal target population for lifestyle interventions because early blood pressure reduction may prevent progression to hypertension. Research indicates that beetroot juice is particularly effective in individuals with elevated baseline blood pressure, suggesting that pre-hypertensive adults may derive substantial benefit. Studies have demonstrated: Reduction in systolic blood pressure within hours of consumption. Sustained reductions with regular intake. Improved endothelial function and vascular health. Potential reduction in future cardiovascular risk **[23**].

- **Kapil *et al*. (2015**) investigated the sustained blood pressure-lowering effects of dietary nitrate in hypertensive and pre-hypertensive adults through a randomized double-blind placebo-controlled study. The findings demonstrated significant improvement in endothelial function, reduced arterial stiffness, and lowered systolic and diastolic blood pressure following nitrate-rich beetroot juice supplementation. The study suggested that dietary nitrate may serve as an effective adjunctive intervention for early blood pressure /management **[17]**.
- **Bahadoran *et al*. (2017)** performed a systematic review and meta-analysis involving 22 randomized clinical trials to evaluate the effects of beetroot juice supplementation on blood pressure. The review reported that beetroot juice significantly reduced both systolic and diastolic blood pressure. The greatest improvements were observed with higher nitrate doses and supplementation lasting longer than 14 days. These findings suggest that beetroot juice may be a useful dietary intervention for lowering blood pressure, particularly among individuals at increased cardiovascular risk, including those with pre-hypertension **[19]**.

CONCLUSION

This systematic review indicates that beetroot juice is a promising dietary intervention for reducing blood pressure in

individuals with pre-hypertension. Findings from randomized controlled trials, systematic reviews, and meta-analyses suggest that regular intake of nitrate-rich beetroot juice can lead to meaningful reductions in both systolic and diastolic blood pressure. These beneficial effects are mainly associated with the conversion of dietary nitrate into nitric oxide, which promotes vasodilatation, improves endothelial function, and decreases peripheral vascular resistance.

The available evidence also suggests that beetroot juice is a safe, affordable, and easily accessible nutritional approach that may help to prevent the progression from pre-hypertension to hypertension. In addition to its nitrate content, beetroot contains several bioactive compounds, including betalains, polyphenols, and antioxidants, which may further support cardiovascular health by reducing oxidative stress and inflammation. Emerging evidence also highlights the importance of the oral microbiome in nitrate metabolism, indicating that multiple biological pathways may contribute to the blood pressure-lowering effects of beetroot juice.

Although the overall findings are encouraging, several limitations should be considered. Differences in study methodology, sample size, nitrate dose, duration of supplementation, and participant characteristics make it difficult to directly compare results across studies. Furthermore, many of the available studies involved relatively short intervention periods, and only a limited number specifically included pre-hypertensive individuals.

Future research should focus on well-designed, large-scale, multicenter randomized controlled trials with longer follow-up periods to determine the optimal dosage, duration of supplementation, and long-term safety of beetroot juice. Such studies will strengthen the existing evidence and support the development of evidence-based recommendations for the use of beetroot juice in the prevention and management of elevated blood pressure.

REFERENCES

[1] Bahadoran Z, Mirmiran P, Kabir A, Azizi F, Ghasemi A. The nitrate-independent blood pressure–lowering effect of beetroot juice: A systematic review and meta-analysis. Advances in Nutrition. 2017;8(6):830–838.

[2] Benjamim CJR, Porto AA, Valenti VE, Sobrinho ACS, Garner DM, Gualano B, Bueno Júnior CR. Nitrate derived from beetroot juice lowers blood pressure in patients with arterial hypertension: A systematic review and meta-analysis. Frontiers in Nutrition. 2022; 9: 823039.

[3] Siervo M, Lara J, Ogbonmwan I, Mathers JC. Inorganic nitrate and beetroot juice supplementation reduces blood pressure in adults: A systematic

review and meta-analysis. Journal of Nutrition. 2013;143(6):818–826.

[4] Kapil V, Khambata RS, Robertson A, Caulfield MJ, Ahluwalia A. Dietary nitrate provides sustained blood pressure lowering in hypertensive patients: A randomized, phase 2, double-blind, placebo-controlled study. Hypertension. 2015;65(2):320–327.

[5] Hobbs DA, Kaffa N, George TW, Methven L, Lovegrove JA. Blood pressure-lowering effects of beetroot juice and beetroot-enriched bread products in normotensive male subjects. British Journal of Nutrition. 2012;108(11):2066–2074.

[6] Bonilla Ocampo DA, Paipilla AF, Marín E, Vargas-Molina S, Petro JL, Pérez-Idárraga A. Dietary nitrate from beetroot juice for hypertension: A systematic review. Biomolecules. 2018;8(4):134.

[7] Clifford T, Howatson G, West DJ, Stevenson EJ. The potential benefits of red beetroot supplementation in health and disease. Nutrients. 2015;7(4):2801–2822.

[8] Webb AJ, Patel N, Loukogeorgakis S, Okorie M, Aboud Z, Misra S, *et al*. Acute blood pressure lowering, vasoprotective, and antiplatelet properties of dietary nitrate via bioconversion to nitrite. Hypertension. 2008;51(3):784–790.

[9] Jones AM. Dietary nitrate supplementation and exercise performance. Sports Medicine. 2014;44(Suppl 1)–S45.

[10] Grönroos R, *et al*. Effects of beetroot juice on blood pressure in hypertension according to European Society of Hypertension guidelines: A systematic review and meta-analysis. 2024.

[11] Kapil, V., Khambata, R. S., Robertson, A., Caulfield, M. J., & Ahluwalia, A. (2015).

[12] Siervo, M., Lara, J., Ogbonmwan, I., & Mathers, J. C. (2013). Inorganic nitrate and beetroot juice supplementation reduces blood pressure in adults: A systematic review and meta-analysis. The Journal of Nutrition, 143(6), 818–826.

[13] Coles, L. T., & Clifton, P. M. (2012). Effect of beetroot juice on lowering blood pressure in free-living, disease-free adults: A randomized, placebo-controlled trial. Nutrition Journal, 11, 106.

[14] Asgary, S., Afshani, M. R., Sahebkar, A., Keshvari, M., Taheri, M., & Jahanian, E. (2016). Improvement of hypertension, endothelial function and systemic inflammation following short-term supplementation with red beet (Beta vulgaris Linn.) juice: A randomized crossover pilot study. Journal of Human Hypertension, 30(10), 627–632.

[15] Bonilla Ocampo DA, Paipilla AF, Marín E, Vargas-Molina S, Petro JL, Pérez-Idárraga A. Dietary nitrate from beetroot juice for hypertension: A systematic review. Biomolecules. 2018;8(4):134.

[16] Bahadoran Z, Mirmiran P, Kabir A, Azizi F, Ghasemi A. The nitrate-independent blood pressure-lowering effect of beetroot juice: A systematic review and meta-analysis. Advances in Nutrition. 2017;8(6):830–838.

[17] Kapil V, Khambata RS, Robertson A, Caulfield MJ, Ahluwalia A. Dietary nitrate provides sustained blood pressure lowering in hypertensive patients: A randomized, phase 2, double-blind, placebo-controlled study. Hypertension. 2015;65(2):320–327.

[18] Asgary, S., Afshani, M. R., Sahebkar, A., Keshvari, M., Taheri, M., & Jahanian, E. (2016). Improvement of hypertension, endothelial function and systemic inflammation following short-term supplementation with red beet (Beta vulgaris Linn.) juice: A randomized crossover pilot study. Journal of Human Hypertension, 30*(10),627*–632.

[19] Bahadoran, Z., Mirmiran, P., Kabir, A., Azizi, F., & Ghasemi, A. (2017). The nitrate-independent blood pressure-lowering effect of beetroot juice: A systematic review and meta-analysis. Advancesin Nutrition, 8*(6), 830–838.*

[20] Jackson, J. K., Patterson, A. J., MacDonald-Wicks, L. K., Oldmeadow, C., & McEvoy, M. A. (2018). The role of inorganic nitrate and nitrite in cardiovascular disease risk factors: A systematic review and meta-analysis of randomized controlled trials. *Nutrition Reviews, 76*(5),348–371.

[21] Bonilla Ocampo, D. A., Paipilla, A. F., Marín, E., Vargas-Molina, S., Petro, J. L., & Pérez-Idárraga, A. (2018). Dietary nitrate from beetroot juice for hypertension: A systematic review. Biomolecules, *8*(4), 134**.**

[22] Benjamim CJR, Porto AA, Valenti VE, Sobrinho ACS, Garner DM, Gualano B, Bueno Júnior CR. Nitrate derived from beetroot juice lowers blood pressure in patients with arterial hypertension: A systematic review and meta-analysis. Frontiers in Nutrition. 2022; 9: 823039.

[23] Grönroos, M., *et al*. (2024**).** Effects of beetroot juice supplementation on blood pressure according to European Society of Hypertension guidelines: A systematic review and meta-analysis.

[24] Padmapriya, R., *et al*. (2024). Efficacy of beetroot juice supplementation on blood pressure among hypertensive patients. *International Journal of Community Medicine and Public Health*, 11(2), 850–855.