Beetroot Juice Supplementation: Effect on Cardiovascular and Cognitive Function in Older Adults

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Abstract. Cardiovascular disease (CVD) is the primary cause of death and disability globally, accounting for nearly one in three fatalities. Implementing lifestyle and dietary changes can help lower blood pressure (BP) and reduce the risk of CVD. Notably, hypertension and CVD risk are more prevalent in Asian populations, a trend expected to rise with aging and increasing wealth among these communities. Many older adults are seeking natural approaches to enhance their health and quality of life, leading to a growing interest in food-based supplements like inorganic dietary nitrate (NO_3^-). Nitrate is abundantly found in green leafy and root vegetables, such as beetroot. It serves as a precursor to nitric oxide (NO), a bioactive molecule with various roles in the body, including the regulation of neurotransmission, blood flow, and oxygen consumption. Research indicates that NO_3^- supplementation may offer benefits for health, cognitive function, and physiological performance in older adults. This paper will explore research supporting beetroot juice supplementation for reducing blood pressure and enhancing cognitive function in older people, its potential mechanisms of action, and practical applications..

1. Introduction

Cardiovascular disease (CVD) remains the leading global cause of death and disability, with a sharp rise expected in Asia—projected to increase by 109% to 729.5 million cases by 2050 [1] (Hypertension is the most significant modifiable risk factor, responsible for 13.3% of CVD-related deaths in Asia [2]. Within Southeast Asian countries, Indonesia, the largest and most populated country in the region, has the highest prevalence of hypertension (42.7% of men and 39.2% of women [3], and the largest share of CVD to total disease burden in SE Asia [4]. Furthermore, of the 51.3 million Indonesian adults aged 30-79 years with hypertension, only 4% have it controlled. Dietary shifts from traditional Asian diets to westernised patterns—high in processed foods and sugars—contribute to increased CVD risk [5]. Asian migrants in high-income countries face added risks due to socioeconomic challenges, food insecurity, and poor access to healthy foods [6]. Many Asian adults prefer natural health strategies over medication [7], making food-based supplements like inorganic dietary nitrate (NO_3^-) increasingly popular. Nitrate is abundant in leafy greens and root

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vegetables like beetroot and is a precursor to nitric oxide (NO), a molecule involved in blood flow, oxygen use, and other physiological functions [8, 9]. However, the potential of NO_3^- supplementation to reduce hypertension and enhance wellbeing in Asian populations needs more work.

2. Results and Discussion

2.1 Dietary Sources of Nitrate and Nitrite

Over 80% of NO_3^- intake comes from the diet, mainly vegetables like spinach, lettuce, and beetroot. Nitrite (NO_2^-) is obtained directly from food or via NO_3^- conversion, or endogenously from NO oxidation. Vegetable NO_3^- levels vary due to cultivar genetics and post-harvest conditions; cold, dark storage preserves NO_3^- better than warm, humid environments [10]. Other sources include drinking water (5–20%), meats (5–15%), and grains/fruits.

2.2 Absorption of Dietary Nitrate

Ingested NO_3^- is absorbed in the stomach and duodenum, then enters the bloodstream [11] . Around 20–25% is concentrated in salivary glands and reduced to NO_2^- by oral bacteria [12]. Some NO_2^- converts to NO in the stomach; the rest circulates and is reduced to NO in tissues via enzymes like deoxyhemoglobin and xanthine oxidoreductase [7]. Nitrite from food can also be directly absorbed and converted to NO in the body [10], supporting various physiological functions depending on its site of action.

2.3 Potential Cardiovascular Benefits of Increasing Nitrate Intake

Numerous studies show dietary NO_3^- supplementation can reduce blood pressure [13, 14, 15, 16]; found that 3 days of sodium NO_3^- (0.1 $mmol \cdot kg^{-1} \cdot day^{-1}$) intake lowered diastolic blood pressure (DBP) by 3.7 mmHg and mean arterial pressure (MAP) by 3.2 mmHg. Beetroot juice doses (4.2–16.8 mmol NO_3^-) showed peak plasma NO_2^- at 2–2.5 hours post-ingestion, aligning with maximal blood pressure reductions. In older adults (60–70 y), 9.6 $mmol \cdot day^{-1}$ NO_3^- reduced systolic (SBP) and DBP by 5 and 3 mmHg, respectively [14,17] demonstrated similar effects in hypertensive rats and humans, with 28 days of beetroot juice (~6.4 $mmol \cdot day^{-1}$) intake lowering blood pressure {13] These findings suggest NO_3^- may be a cost-effective alternative to medication to reduce blood pressure, especially for older adults with reduced NO bioavailability [18]Beyond blood pressure, NO_3^- improves endothelial function and blood flow [13,19]. Foods high in NO_3^- inhibit platelet aggregation and reverse endothelial dysfunction (Webb et al., 2008), which is especially relevant for older adults [20]. Nitrate supplementation offers an alternative NO pathway when NOS activity declines. Animal studies show NO_3^- reduces arterial stiffness, inflammation, and smooth muscle proliferation [21]. In humans, 28 days of NO_3^- (~6.4 $mmol \cdot day^{-1}$) intake reduced pulse wave velocity and improved flow-mediated dilation (~20%) in hypertensive adults [13]. [19] also found increased muscle blood flow and walking time in older adults with peripheral arterial disease after a single beetroot juice dose (~9 mmol NO_3^-). However, findings on endothelial function remain mixed, and further research is needed, especially in older populations [11].

2.4 Impact on Cognitive Function and Wellbeing

Age-related declines in cerebral blood flow (CBF), partly due to reduced NO production, are linked to cognitive impairment and dementia risk [12]. Dietary NO_3^- supplementation may enhance CBF and cognitive function in older adults [20]Improvements in reaction time and mental processing have been observed in older adults with type 2 diabetes [22]. young adults during exercise [23], and healthy adults [24]. Dietary NO_3^- supplementation may support healthy ageing by improving cardiovascular and cognitive function, especially in older adults with diminished endothelial vasodilation [19]. Beetroot juice also has antioxidant properties that enhance NO bioavailability via NOS activity [25]. Betanin, a beetroot pigment, activates antioxidant pathways through Nrf2 expression [26]. Given the role of diet in ageing and disease, food-based NO_3^- supplementation offers a promising strategy for promoting metabolic health as well.

2.5 Effect of Nitrate Supplementation on Health Outcomes in Asian People

Asian people with hypertension have some unique characteristics including increased intake and sensitivity to salt ingestion, higher impact of obesity on blood pressure, loss of diurnal rhythm in blood pressure and primary aldosteronism [27]. There is a clear recognition by Asian people that food choice and lifestyle affect metabolic health . Although the benefits of dietary NO_3^- supplementation is emerging within western populations there is scant evidence in Asian people. Similarly, the cardiovascular and metabolic benefits of dietary NO_3^- supplementation, particularly from beetroot juice, have been increasingly validated in western cohorts, but evidence in Asian populations remains sparse. This presents a critical gap, especially given the unique physiological and cultural contexts that may modulate both efficacy and acceptability of this kind of supplementation.

3. Conclusion

Dietary NO3- supplementation, after reduction to NO, has many potential benefits including reduction in blood pressure, improved cognitive function and wellbeing. It is also evident that these effects can be present in both younger and older populations, with the potential for greater benefits in older adults. Asia has an aging population, high incidence of hypertension (with unique characteristics) and increased challenges of western diet and lifestyle. However, there is little research on the effect of dietary NO3- intake (especially via beetroot juice) on reducing risk factors of hypertension in Asian populations – especially in Indonesia which has the highest incidence of hypertension and CVD in Southeast Asia. This research is warranted, especially as Asian consumers are increasingly valuing the effect of functional foods on their health and wellbeing.

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