Anthocyanin intake and Arterial Stiffness: A Literature Review

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Abstract

There is a well-established association between aging, arterial stiffness, endothelial dysfunction, oxidative stress and the ensuing increased cardiovascular risk. Agents with antioxidant activity can improve endothelial function and arterial stiffness. Açaí-juçara is a fruit rich in anthocyanins, which are powerful antioxidants, and its daily consumption may have beneficial effects on vascular health, especially on central pulse pressure and pulse wave velocity. As anthocyanins may improve vascular health, especially central pulse pressure, dietary intake of anthocyanin-rich foods may reduce cardiovascular risk. Thus, this study aimed to review the effects of dietary intake of anthocyanins and its potential associations with central blood pressure improvement in overweight and obese individuals.

Keywords: Arterial stiffness; Hyperinsulinemia; Hypertriglyceridemia; Cardiovascular diseases; Cholesterol

Abbreviations: WHO: World Health Organization; PWV: Pulse Wave Velocity; ROS: Reactive Oxygen Species; CRP: C-reactive Protein; CPP: Central Pulse Pressure; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; DRI: Dietary Reference Intake

Introduction

The prevalence of overweight and obesity has increased exponentially in recent years. Obesity is characterized by excess accumulation of body fat and is associated with increased risk of morbidity and mortality [1]. According to data from World Health Organization (WHO), in 2016, 39% of women and 39% of men aged 18 and over were overweight [2].

Obesity is strongly associated with cardiovascular outcomes. The mechanisms involved are complex and multifactorial. Some researchers suggest that obesity is a clinical condition associated with a low-intensity inflammatory state resulting from an imbalance between pro- and anti-inflammatory molecules due to increased production of pro-inflammatory molecules. Besides, visceral adiposity, glucose intolerance, hyperinsulinemia, hypertriglyceridemia and oxidative stress can lead to changes in vascular function [3]. It is thus important to identify individuals with accelerated vascular aging for early specific interventions targeting multiple risk factors [4].

Changes in vascular function can be assessed through pulse wave analysis. Pulse Wave Velocity (PWV) is an earlier marker of vascular wall changes [5] and it can be measured by applanation tonometry and an oscillometric method.

Experimental, epidemiological and clinical studies have shown that consumption of bioactive compounds present in fruits can decrease the oxidative damage and inflammation due to their antioxidant activity. The dietary intake of antioxidants can protect the body against the harmful effects of oxygen radicals with a positive impact on several chronic conditions including obesity, diabetes and neurodegenerative and cardiovascular diseases, and may improve endothelial function [6,7].

Açaí-juçara is the fruit of a Juçara palm tree (Euterpe Edulis Martius) that is rich in antioxidants, especially anthocyanins [8]. Recent studies of anthocyanin-rich extracts have shown their potential antioxidant role with significant reduction of blood pressure, strong anti-inflammatory activity and decrease of oxidative stress [6,7]. Although daily intake of açai may have cardiovascular benefits, its impact on central blood pressure parameters is still controversial. Thus, our study aimed to review the effects of anthocyanin intake and its potential associations with central blood pressure improvement in overweight and...
Arterial stiffness and vascular aging

Arterial stiffness is an important parameter that reflects the mechanical properties of blood vessels. It is determined by the balance between the elastic properties of the arterial wall and the hemodynamic forces acting on it [24]. An increased arterial stiffness is associated with the development of various cardiovascular diseases, including hypertension, atherosclerosis, and cardiovascular mortality [25].

The arterial wall is composed of three layers: the intima (innermost layer), the media (middle layer), and the adventitia (outermost layer). The biomechanical properties of the arterial wall are influenced by the composition of these layers. The intima primarily contains smooth muscle cells, whereas the media is composed of elastic fibers and collagen. The adventitia is mainly composed of connective tissue cells, including fibroblasts and smooth muscle cells [26].

The arterial stiffness can be measured using various methods, such as the pulse wave velocity (PWV) or the augmentation index (AI) [27]. PWV is defined as the speed at which the pressure pulse propagates along the arterial tree. It is calculated as the difference in time between the arrival of the pressure wave at two points divided by the distance between them. PWV is inversely proportional to the arterial compliance and is considered an established biomarker of arterial stiffness [28].

The AI is another measure of arterial stiffness that reflects the wave reflection process in the arterial system. It is defined as the ratio of the reflected wave to the incident wave and is expressed in percentages. An increased AI indicates a higher degree of arterial stiffness and reflects the presence of wave reflections at various sites along the arterial tree [29].

Free radicals and oxidative stress

Free radicals are highly reactive molecules that contain one or more unpaired electrons. They are produced during normal metabolic processes or as a result of environmental factors, such as smoking and pollution. Free radicals can react with lipids, proteins, and DNA, leading to oxidative damage and cell dysfunction [30].

Oxidative stress is defined as an imbalance between the production of reactive oxygen species (ROS) and the antioxidant defense system of the body. ROS are generated during normal cellular metabolism, primarily by oxygen and nitrogen radicals, and can cause oxidative damage to cell components, such as lipids, proteins, and nucleic acids [31].

Antioxidant intervention: anthocyanins

Anthocyanins are a class of pigments found in various plant foods, such as berries, red wines, and blueberries. They are known for their antioxidant properties and have been shown to have beneficial effects on vascular health [32].

Multiple studies have demonstrated the ability of anthocyanins to reduce oxidative stress and improve vascular function. For example, in a study by Wu et al. [33], anthocyanin-rich grapes were fed to rats, and the results showed a significant reduction in blood pressure and improved vascular function. Similarly, a study by Fan et al. [34] demonstrated that anthocyanins in red wine improved endothelial function and reduced arterial stiffness in hypertensive rats.

Conclusions

In conclusion, arterial stiffness and oxidative stress play important roles in the development of various cardiovascular diseases. Antioxidant interventions, such as the consumption of anthocyanin-rich foods, have been shown to have beneficial effects on vascular health. Further research is needed to better understand the mechanisms underlying these effects and to develop effective strategies for reducing arterial stiffness and oxidative stress.
There are no recommended Dietary Reference Intake (DRI) values for phytochemicals. It has been demonstrated that synthetic antioxidants can prevent or attenuate ROS harmful effects both in vivo and in vitro. Studies have reported anti-inflammatory, cardioprotective and anti-obesogenic benefits of dietary intake of phytochemical compounds, especially anthocyanins, in the human body [6, 7, 38].

According to the European Food Safety Authority and FAO/WHO Expert Committee on Food Additives (JECFA), the daily consumption of anthocyanins (2.5mg/kg body weight) is safe. In their review study, Pojer found that toxicity risks of dietary supplementation of anthocyanins are extremely low and even an intake of 160mg twice a day (320mg/day) was well-tolerated with no reported side effects [39].

Fairlie-Jones et al. [40] conducted a meta-analysis of randomized controlled trials to assess the effect of anthocyanin-rich extracts on vascular function in adults. Their results support the findings that anthocyanins may improve vascular health, especially flow-mediated dilation with acute and chronic supplementation and PWV with acute supplementation [40].

In a cross-sectional study of 1,898 women from the UK Adult Twin Registry (TwinsUK), higher anthocyanin intake was associated with significantly lower central SBP, lower PWV and reduced arterial stiffness [41].

Açaí and berries

Natural foods as antioxidant sources have gained increasing attention [42]. Açai is a fruit rich in anthocyanins. There are two species: conventional açaí (Euterpe Oleracea Mart) and açaí-juçara from Juçara palm tree (Euterpe Edulis Martius). The dry matter content of açaí-juçara has high content of phenolic compounds, such as ellagic acid and anthocyanins, and exhibits potent antioxidant activity [43].

Anthocyanins found in the açaí-juçara pulp vary from 60mg to 410mg/100g wet matter and the antioxidant content shows seasonal and harvest area variation [43, 44]. In addition to its high content of anthocyanins, açaí-juçara is a natural source of fibers, oleic and linolenic acid and other micronutrients such as vitamin E.

Many studies have evaluated the dose-response relationship and effects/effectiveness of antioxidant supplementation in the human body [45] and in animals [46]. It has been demonstrated that dietary supplementation of 2% and 6% lyophilized açaí in apolipoprotein E-deficient (ApoE -/-) mice improved their lipid profile and antioxidant defense and showed a hypoglycemic effect [46]. Another study found that dietary intake of anthocyanins at 0.90 mg/day was associated with reduced risk of developing cardiovascular disease in post-menopausal women [47]. Significant lower levels of fasting plasma glucose, insulin, cholesterol, triglycerides, exhaled nitric oxide metabolites (breath) and ultra-sensitive plasma CRP (hs-CRP) were found in overweight individuals following a 30-day intake of 100mL of açaí pulp twice a day [48]. Other studies have demonstrated reductions in fasting blood glucose and insulin levels, total cholesterol, LDL-cholesterol and total cholesterol-to-HDL ratio and, therefore, reduced markers of metabolic syndrome risk [32, 34].

Furthermore, the consumption of açaí has been associated with decreased insulin and glucose levels in overweight men. Evidence shows that dietary intake of açaí containing approximately 690 mg of phenolics and anthocyanins is associated with improvement in vascular function. This benefit appears to be associated with improvement of redox status [49].

Conclusion

Structural degenerative damage of arterial elastic components is little reversible with drug therapies currently available. It is thus extremely important to assess the impact of preventive interventions for reducing vascular stiffness and accelerated vascular aging. Dietary intake of anthocyanin-rich foods has shown several health benefits and may reduce cardiovascular risks. The effects of anthocyanin intake, especially açaí-juçara, on central blood pressure parameters should be further investigated in randomized controlled trials to support the assumed benefits of arterial stiffness improvement.

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