Antihypertensive effects of astaxanthin

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Abstract: Astaxanthin is a biological antioxidant naturally found in a wide variety of aquatic living organisms, and has shown various pharmacological activities, such as anti-inflammatory and antidiabetic activities. A recent study reported that the administration of astaxanthin induced a significant reduction in blood pressure and delayed the incidence of stroke in stroke-prone spontaneously hypertensive rats, suggesting that astaxanthin also has antihypertensive effect. In a study using aortic rings of spontaneously hypertensive rats, astaxanthin induced a significant reduction of the contractile responses of the aorta to α-adrenergic receptor agonist and angiotensin II, which may contribute to the antihypertensive effect of astaxanthin. In a histopathological study, astaxanthin decreased coronary artery wall thickness compared with the control, indicating the possibility that astaxanthin ameliorates hypertension-induced vascular remodeling. Astaxanthin has anti-inflammatory, antidiabetic, antihypertensive, and antioxidative activities; therefore, we should perform further studies to elucidate an antiatherogenic effect of astaxanthin.

Keywords: astaxanthin, antioxidant, antihypertensive effect, atherosclerosis

Introduction

Astaxanthin, a red-orange carotenoid pigment, is a biological antioxidant that naturally found in a wide variety of aquatic living organisms, such as shrimp, crab, and salmon (Higuera-Ciapara et al 2006). The green microalgae *Haematococcus pluvialis* and the red yeast *Phaffia rhodozyma* are common sources of natural astaxanthin (Higuera-Ciapara et al 2006). Astaxanthin has shown various pharmacological activities, including anti-inflammatory (Kurashige et al 1990; Ohgami et al 2003) and antidiabetic activities (Uchiyama et al 2002), as well as antioxidative effects (O'Connor et al 1998; Iwamoto et al 2000; Kang et al 2001; Aoi et al 2003). Here, we discuss an antihypertensive effect of astaxanthin.

Antihypertensive effects of astaxanthin

Hussein et al (2005) investigated an antihypertensive effect of astaxanthin in spontaneously hypertensive rats (SHR), which have been widely used as a model to study the mechanism, pathophysiology, and management of hypertension. The administration of astaxanthin at the doses of 50 mg/kg for 5 weeks demonstrated a significant reduction in the systolic blood pressure (BP) (–4%) and in the diastolic BP (−10%), and also delayed the incidence of stroke in stroke-prone SHR. In the study using aortic rings with intact and denuded endothelia, astaxanthin-induced vasodilation by both endothelium-dependent and endothelium-independent manners. They also investigated the effect of astaxanthin on nitric oxide (NO), which plays a major role on regulation of vascular tone and arterial blood pressure-mediated vasorelaxation. Astaxanthin-mediated vasorelaxation is NO-dependent at the lower dose (30 μM), and is NO-independent at the higher dose (100 μM).

The underlying mechanisms for antihypertensive effects of astaxanthin

To reveal the underlying mechanisms for antihypertensive effect of astaxanthin, Hussein et al (2005) evaluated vascular reactivity of the SHR abdominal aorta, induced

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by various substances that modulate vascular tone and blood pressure. Astaxanthin induced a significant reduction of the contractile responses of the aortic preparations to α-adrenergic receptor agonist, phenylephrine, suggesting that astaxanthin may decrease BP by ameliorating the sympathetic pathway, especially via α-adrenergic receptor. Astaxanthin also demonstrated a significant reduction of the contractile responses to angiotensin II, which has been reported to increase superoxide in cultured vascular smooth muscle cells (Griendling et al 1994). Superoxide was increased in rats that became hypertensive by chronic infusion with angiotensin II (Rajagopalan et al 1996). These results indicate that astaxanthin-mediated reduction of the contractile responses of aorta to angiotensin II may be at least partially due to superoxide scavenging effect of astaxanthin.

Astaxanthin has no effect on the endothelium-dependent acetylcholine-induced vasodilation; however, it has a significant enhancing effect in the endothelium-independent sodium nitroprusside (SNP)-induced vasodilation, which challenges previous results. SNP is an endothelium-independent vasorelaxant agent and its effect is attributed to its direct effect on vascular smooth muscles. However, a recent experiment showed that endothelium potentiates the SNP-mediated vasorelaxation, suggesting a significant association between endothelium-mediated vasorelaxation and the SNP-mediated vasorelaxation (Bonaventura et al 2008). Further investigations should be necessary, to elucidate the association between astaxanthin-mediated vasorelaxation and endothelium-mediated vasorelaxation.

Hussein et al (2006) investigated the effect of astaxanthin on plasma levels of NO end products nitrite/nitrate (NO_2^-/NO_3^-, termed NOx) in SHR. The synthesis of NO by vascular endothelium is responsible for vascular tone which plays an essential role in regulation of BP (Rand et al 1992). Because NOx are relatively stable in the blood, plasma NOx concentration has been reported to be an indicator of endogenous NO production (Rhodes et al 1995). Oral administration of astaxanthin significantly reduced plasma NOx levels compared with control rats (Hussein et al 2006). We should study the influences of astaxanthin on NO metabolism including degradation and excretion as well as production.

In a histopathological study, astaxanthin decreased coronary artery wall thickness compared with the control, and significantly reduced the elastic fiber in the aorta, suggesting the possibility that astaxanthin ameliorates hypertension-induced vascular remodeling (Hussein et al 2006).

Future perspectives

The underlying mechanisms for development of hypertension in the metabolic syndrome, which is characterized by the simultaneous occurrence of metabolic abnormalities including obesity, glucose intolerance, dyslipidemia, are very complicated. Sympathetic overactivity, oxidative stress, and activated renin-anigiotensin system have been suggested to be possible factors for developing hypertension in the metabolic syndrome (Yanai et al 2008). Astaxanthin has a superior antioxidant activity, and induces a significant reduction of the contractile responses of the aorta to α-adrenergic receptor agonist and angiotensin II. Astaxanthin may be effective for the management of hypertension in the metabolic syndrome as well as essential hypertension.

Astaxanthin has anti-inflammatory, antidiabetic, antihypertensive, and antioxidative activities; therefore, we should perform further studies to elucidate an antiatherogenic effect of astaxanthin.

Disclosures

The authors have no conflicts of interest to disclose.

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