

Especially anthocyanidins, phenolic acids and quercetin glycosides have protective effects against peroxynitrite-induced nitration damage of plasma fibrinogen and, therefore, may contribute to the prevention of peroxynitrite-related cardiovascular diseases¹³⁰ Furthermore, Bijak et al.¹²⁹ estimated the effect of Aronia berries' extract against nitration and oxidative damage induced by peroxynitrite. The antioxidant properties of the black chokeberry extract on oxidative/nitration stress in human blood platelets were studied in vitro.

Ryszawa et al.¹³¹ studied the effects of polyphenol-rich extracts of black chokeberries on platelet function in vitro and in vivo in subjects with significant cardiovascular risk factors, such as hypertension, hypercholesterolemia, smoking and diabetes mellitus. Results showed that Aronia anthocyanins extract administration caused an increase of glutathione peroxidase and catalase activities in red blood cells. Furthermore, Kowalczyk et al.¹²⁴ observed the influence of Aronia anthocyanins extract from berries on selected parameters of oxidative stress in young men with hypercholesterolemia that have taken extracted anthocyanins of 240 mg daily for 30 days.

In this way, chokeberry fruit derivatives can also have a beneficial effect on several mentioned risk factors for cardiovascular diseases^{123, 124, 125, 126} The fruits are beneficial due to multiple mechanism of action-influence on lipid metabolism, peroxidation, process of inflammation, coagulation and oxidation, as well. [Aronia](#) extracts decrease risk factors related to insulin resistance by modulating multiple pathways associated with insulin signaling, adipogenesis and inflammation^{116, 120} Aronia melanocarpa anthocyanins can normalize the carbohydrate metabolism in diabetic patients and in streptozotocin-diabetic rats¹¹⁹ Clinical evidence showed that polyphenol-rich natural products modulate the carbohydrate metabolism by various mechanisms such as restoring beta-cells' integrity and physiology and enhancing insulin releasing activity. Anthocyanins such as cyanidin 3-rutinoside could potentially inhibit intestinal α -glucosidase, retard the absorption of sugars^{115, 117, 118} and be useful in the prevention and control of diabetes mellitus, as well¹¹⁹ Worsztynowicz et al.¹¹⁵ investigated the effect of black chokeberry extracts on the activity of porcine pancreatic α -amylase and lipase, which are key enzymes in the digestive system.

Chokeberries are a rich source of anthocyanins, which may contribute to the prevention of obesity, which is associated with the reduction of sugars and lipids absorption in the digestive system. The results of the experiment showed that fruit juice reduced indomethacin-induced gastric mucosal injury. A virucidal assay was used to test Aronia's anti-influenza efficacy against different strains of seasonal and oseltamivir-resistant influenza virus in the study of Park et al. 112 The Aronia fruit that contains several polyphenolic constituents possesses in vitro and in vivo efficacy against different subtypes of influenza viruses (H1/K09, H3/PE16, B/BR60), including an oseltamivir-resistant strain (H1/K2785 and HPAI rH5/IS06).

Anti-Inflammatory Effect of Black Chokeberry Fruit as a Base of Antibacterial and Antiviral Activity. However the immunomodulatory activity is not associated with Aronia anthocyanins; they had only a slight effect on reducing IL-10. The complement-modulating activities, the inhibitory activities on nitric oxide production in LPS-induced RAW 264.7 mouse macrophages of procyanidins C1, B5 and B2 and anthocyanins of Aronia melanocarpa were examined by Ho et al. 101 Results of the experiment showed that procyanidins C1, B5 and B2 and anthocyanins are mainly responsible for the immunomodulation effect.