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An overview of phytochemicals and potential health-promoting properties of black walnut

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Black walnut (*Juglans nigra* L.) is one of the most widely consumed nuts in the United States. The nut has been recognized for its unique, bold flavor, and used as a versatile food ingredient. The objective of this review is to summarize available research data pertaining to phytochemicals present in black walnut and their previously reported health-promoting properties. Black walnut is rich in phenolics and contains higher levels of phytosterols, unsaturated fatty acids and tocopherols than many other commonly consumed nuts. Dietary intervention of these constituents has been associated with a great number of disease-preventive properties. Black walnut has a potential to inhibit the release of proinflammatory mediators *in vitro*. Similarities in contents of unsaturated fatty acids and tocopherols between black walnut and English walnut suggest that black walnut consumption may produce beneficial effects on cardiovascular disease risks. In addition, the high level of γ -tocopherol in black walnut could make the nut a cancer-preventive option. Although evidence has shown black walnut kernel is a rich source of phytochemicals of potential importance to human health, there is a paucity of *in vitro* and *in vivo* studies on the bioactivities of these phytochemicals isolated from black walnut and the health-promoting properties of black walnut consumption. Clinical studies are needed to better understand the health benefits of black walnut.

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1. Introduction

Black walnut (*Juglans nigra* L.), native to North America, is a member of the walnut family (Juglandaceae). Black walnut trees are highly valued for their distinctively flavored nuts that have a long history of use as a food ingredient (Fig. 1). And though the tree nut is quite an ordeal to extract, it provided valuable food for indigenous Americans. Alternate bearing is a characteristic of this walnut species, with the size of the crop ranging from 4.5–15.9 thousand tons (fresh weight, hulled).¹ Over 15.5 thousand tons of black walnut was produced in 2017, resulting in approximately 1860 tons of edible nutmeat (12% yield), while the figures for 2018 and 2019 dropped by 60%.^{1–3} The production still predominantly relies on harvesting and processing from wild nut trees. As black walnut is one of the few crops still hand-picked, it is considered a hands-on product, making it all natural and entirely sustainable. Currently, Hammons Products Company, based in Stockton, Missouri, is the sole, large-scale processor and supplier of black walnut nutmeat and shell products in the United States. Approximately 65% of the annual harvest comes from Missouri, USA.

Compared to English walnut or Persian walnut (*Juglans regia* L.), black walnut has a sweeter, mustier, more complex flavor, making it a versatile ingredient for candies, baked goods and ice cream.⁴ Nutritionally, black walnut is an excellent source of vitamins (folic acid, vitamin B5, vitamin B6, tocopherols), minerals (phosphorus, manganese, magnesium, zinc, potassium), omega-3 fatty acids, and phytochemicals.⁵ Consumption of black walnut may exert a beneficial effect on human vascular function.⁶ Derivatives of black walnut kernels, husk, bark and leaves are thought to have a variety of medicinal properties. For example, a tincture of the nuts, green husk, and leaves is traditionally used in folk medicine as a treatment for biliary and cramp colic, and in removal of intestinal worms.⁷ Dated back in late 1960s, extracts of black walnut leaves and husk were reported to exhibit an antitumor activity in a mouse study.⁸ Recently, evidence has indicated that black walnut kernel extracts possess great potentials to suppress the pro-inflammatory cytokine production in LPS-induced human promonocytic cell line U-937.⁹ In addition, black walnut kernel extracts have shown inhibitory effects on the growth of bacteria including *Staphylococcus aureus*.^{10,11} It is proposed that these bioactivities are attributed to the presence of phytochemical constituents in black walnut. While some researchers relied on traditional fractionation of black walnut extracts to isolate and characterize bioactive components others have taken advantage of advanced computational algorithms and freely available metabolite databases to tentatively identify compounds

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