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Nuts and their co-products: The impact of processing (roasting) on phenolics, bioavailability, and health benefits – A comprehensive review

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ABSTRACT

Nuts serve as important healthful snacks worldwide. They are highly desirable due to the presence of numerous essential macro- and micronutrients and health-promoting phenolic compounds (polyphenols). Nuts are usually consumed either as raw (natural) or as roasted. In addition, nuts and their co-products have been demonstrated to be rich sources of phenolic compounds that possess various health-beneficial properties. Therefore, inclusion of these phenolic compounds from nut co-products into the human diet is highly recommended as these may provide inexpensive sources of natural antioxidants for use as functional food ingredients and nutraceuticals. Hence, the phenolic compositions and antioxidant activities of nuts (natural and roasted) and their co-products (such as skin, hard shell, hull, and pellet) are discussed in detail. The impact of processing (roasting) on nut phenolics and antioxidant activities are highlighted. The bioavailability and health benefits of the phenolic compounds from nuts, especially their co-products are also discussed. Research findings from the existing literature published within the last 10 years have been compiled and summarised.

Contents

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1. Introduction

Tree nuts are dry fruits with one seed in which the ovary wall becomes hard at maturity (Alasalvar & Shahidi, 2008). Common edible tree nuts include almond, Brazil nut, cashew, hazelnut, macadamia, pecan, pine nut, pistachio, and walnut, but the consumer definition also includes peanut, which is botanically a legume, but has a nutrient profile similar to those of tree nuts and is thus identified as part of the nut food group (Alasalvar & Shahidi, 2008; Ros, 2015).

Nuts are nutrient dense foods and have been a regular constituent of mankind's diet (Alasalvar & Shahidi, 2008). Nuts are a convenient and tasty snack that contribute to a healthful dietary pattern. They are usually consumed as whole nuts (either as raw or roasted or salted) (Alasalvar & Shahidi, 2008). Nuts contain high amounts of vegetable protein and fat-soluble bioactives (unsaturated fatty acids, phytosterols, phospholipids, phytostanols, essential oils, sphingolipids, tocopherols, tocotrienols, terpenoids, and squalene). Besides, they are also dense in a variety of other nutrients and provide dietary fibre, vitamins (e.g., folic acid, niacin, vitamin B_6, and vitamin E), minerals (e.g., calcium, magnesium, and potassium), and many other phytochemicals such as phenolic acids, flavonoids, lignin, hydrolysable tannins, proanthocyanidins (condensed tannins), carotenoids, alkaloids, coumestan, and phytates, among others (Alasalvar & Bolling, 2015; Alasalvar & Shahidi, 2008; Bolling, Chen, McKay, & Blumberg, 2011; Bolling, McKay, & Blumberg, 2010b; Chen & Blumberg, 2008; Lainas, Alasalvar, & Bolling, 2016; Maguire, O'Sullivan, Galvin, O'Connor, & O'Brien, 2004; Ryan, Galvin, O'Connor, Maguire, & O'Brien, 2006).

A healthy diet supplemented with one daily serving of nuts prevents cardiovascular events (Ros, 2015) and possibly the development of other chronic diseases, including type II diabetes, cancer, high blood pressure, and neurodegenerative diseases (Afshin, Micha, Khatibzadeh, & Mozaffarian, 2014; Grosso et al., 2015; Kendall, Josse, Esfahani, & Jenkins, 2010; Kochar, Gaziano, & Djoussé, 2010; Luo et al., 2014; Ros, 2010; Zhou et al., 2014). The mechanism for these health effects probably lies in the synergistic interaction of the many bioactive constituents of nuts, which may all favourably influence human physiology (Liu, 2003, 2004). Despite the fact that tree nuts are high-fat and energy-dense foods, epidemiological studies and clinical trials suggest that regular nut consumption is unlikely to contribute to obesity and may even help in weight loss when consuming an energy-restricted diet (Ros, 2010; Vadivel, Kunyanga, & Biesalski, 2012). For this reason, the American Heart Association (Lloyd-Jones et al., 2010; Stone et al., 2014), the Canadian Cardiovascular Society (Anderson et al., 2013), the US Food and Drug Administration (US Food and Drug Administration, 2003), and the US Department of Agriculture (US Department of Health & Human Services and US Department of Agriculture, 2015) have recommend the regular consumption of nuts to the general population, in the context of a healthy diet.

Tree nuts rank third behind spices and fruits for containing the most phytochemicals (Pérez-Jiménez, Neveu, Vos, & Scalbert, 2010). Tree nuts and their co-products (skin or testa, hard shell, green leafy cover, hull, and leaf, among others) are rich sources of phytochemicals that possess multifunctional properties such as antioxidant activities, anti-carcinogenic, anti-mutagenic effects as well as anti-proliferative potential (Alasalvar, Hoffman, & Shahidi, 2008; Alasalvar & Shahidi, 2008; Oliveira et al., 2007; Shahidi, Zhong, Wijeratne, & Ho, 2008). These phytochemicals directly or indirectly provide protection against harmful free radicals and may reduce the risk of non-communicable diseases (NCDs) associated with oxidative stress. Therefore, inclusion of bioactive phytochemicals from tree nut co-products into the diet is of great interest as these may provide inexpensive sources of natural antioxidants for use as functional ingredients and nutraceuticals (Alasalvar et al., 2008; Alasalvar & Shahidi, 2008, 2009).

In the last decade, several different phenolic compounds were characterised and identified in nuts and their co-products