Almonds as functional food: a review

Neda Hashemi*
Young Researchers and Elite Club, Sabzevar Branch, Islamic Azad University, Sabzevar, Iran.
*Corresponding author Email: neda.hashemi81@yahoo.com

Sayed Ali Mortazavi
Department of Food Science and Technology, Faculty of Agricultural Engineering, Ferdowsi University, Mashad, Iran.

Elnaz Milani
Institute of Food Science and Technology, Mashhad ACECR, Iran.

Faride Tabatabai Yazdi
Department of Food Science and Technology, Faculty of Agricultural Engineering, Ferdowsi University, Mashad, Iran.

Abstract
Almonds are high energy nuts and rich in unsaturated fatty acids. In addition the complex matrices of almond contain many bioactive compounds such as α-tocopherols, and phenolic compounds, which are high in a variety of helpful antioxidants or phytochemicals that shield against the damaging effects of free radicals. The phenolic compounds were identified not only in almond and its skin, but also in shell and hull.The essential fatty acid profile, phytochemical compounds and dietary fiber probably lead to almond identification as a functional food. Because of their unique composition, almond consumption could be useful to decrease cholesterol and protect humans from coronary artery diseases, lipid oxidation, diabetes and colon cancer. And also almonds are likely to benefit newer cardiovascular risk biomarkers, such as LDL oxidizability, inflammatory molecules, and endothelial dysfunction.

Keywords: Almond, Bio active, Antioxidant component, Functional food

Introduction
The almond nut (*Amygdalus communis L.*) is a species of Prunus belonging to the family of Rosaceae. The largest genus by far is Prunus, which include plums, cherries, peaches, apricots and almonds (Ren et al., 2009). This tree comes from plateaus and mountains of western Asia, particularly in Iran. Since 1977, USA, has become the largest producer of almond in the world and the recent annual production has exceeded 730000 MT, accounting 80% of global production. Almonds have been used as part of a human diet throughout history especially in Mediterranean ecology (FAO, 2011). Almonds nuts have gained more attention since last decades due to high nutrient density and health benefits associated

with their consumption (Ros., 2010). Almond-based ingredients add flavor and texture to a broad spectrum of products. Almond nuts with or without the brown skin are popular which are often used as a snack food (raw and processed forms) and also they are consumed as a part of a meal either as whole (fresh or roasted), in spreads (almond paste) or hidden (e.g., commercial products, sauces, baked goods, and oils (Fukuda et al., 2005). Sweet almonds are used as the basis of sweets such as marzipan, nougat, baklava and macaroons. They are especially useful in baking and can be substituted for flour to create a dense, moist texture in cakes and biscuits. Almonds nuts are valued for their protein, essential fatty acids, dietary fibers and several important micronutrients like potassium, magnesium, calcium, tocopherols and arginine(Ros., 2009). Moreover, almonds belonging to the group of tree nuts which also contain wide range of phytonutrients such as carotenoids, phenolics acids, phytosterols, polyphenols, spingolipids (β-sitosterol, daucosterol, uridine, and adenosine) (Sang et al., 2002a, Sang et al., 2002b) and dietary fiber. Due to this array of essential nutrients in almond nuts, they are being as a functional food (Heim et al., 2002, Gnanavinthan et al., 2013). Consumptions of almonds have also been related with reduction of heart disease, certain cancer risks, gallstones formation and many beneficial metabolic effects (Chen et al., 2008, Ros, 2010, Bolling et al., 2011). Moreover, U.S. Food and Drug Administration (FDA) has also recognized nuts as "heart-protective" foods (FDA, 2011).
The main objective of this research is to discuss almond as potential sources of bioactive compound such as natural antioxidants, fiber and provide a comprehensive evaluation of the biologically active components present in nuts that could be used in healthy diet.

Almond's bioactive compounds

Bioactives are compounds that produce physiological effects when present in a living material, in other words they must exert physiological benefits related to promoting health (Aluko et al ., 2011, Awika et al., 2011). Bioactives can be classified based on molecular identity or biopolymer type that includes polyphenolic compounds, indigestible carbohydrates (dietary fibers), functional lipids (mainly in nuts), proteins and carotenoids (Cummings et al., 2009). Foods that contain bioactives components are called functional foods. They may cause physiological effects on the consumer, leading to justifiable claims of health benefits (Roberfroid., 1996, Shahidi, 2009). Plants are a rich source of bioactive compounds (Awika et al., 2011). Bioactives from fruits show not only antioxidant activity but also antimicrobial, anticarcinogenic and anti-inflammatory activity (Emilio, 2007).

Phenolics

Phenolic compounds are the most desirable food bioactives which commonly found in both edible and inedible parts of plants (Shahidi et al, 2008). They are responsible for inhibiting or delaying the oxidation of different biomolecules, scavenging reactive oxygen species and chelating metal ions (Gnanavinthan., 2013) (Heim et al., 2002). According to Table.1 a variety of phenolic compounds such as phenolic acids, flavonoids, and other polyphenols have been isolated from almonds(Shahidi et al, 2008). The tannin fraction of almond has the highest content of total phenolics and the highest antioxidant efficiency among all phenolics. The analysis of almond seed crude extract showed the presence of phenolic compounds, namely vanillic, caffeic, p-coumaric, ferulic acids (after basic hydrolysis), quercetin, kaempferol and isorhamnetin (after acidic hydrolysis), delphinidin and cyanidin (after n-butanol-HCl hydrolysis) (Amarowicz 2005). And also Wijeratne et al. (2006a) reported that extracts of defatted almond whole seed, brown skin, and green shell contained quercetin, isorhamnetin, quercitrin, kaempferol 3-O-rutinoside, isorhamnetin 3-O-glucoside, and morin as the major flavonoids in them.

Flavonoids

Flavonoids include flavanols, flavonols, flavononols, flavones, isoflavones and flavanones (Shahidi et al., 2008). Among nuts, almonds have an appreciable content of flavonoids with 18 mg/100 g. Also they are the only nuts that contain flavanones and flavonols (Bolling et al., 2010). Almond whole seed contains a number of flavonoids such as quercetin, isorhamnetin, quercitrin, kaempferol 3-O-rutinoside, isorhamnetin 3-O-glucoside, and morin as the major flavonoids in the extract of defatted almond whole seed (Wijeratne et al. 2006b).

Proanthocyanidins

Proanthocyanidins are the predominant polyphenols in almonds. Nut proanthocyanidins mainly consist of (+)-catechin and (-)-epicatechin, but also include afzelechin and epigallocatechin (Gu 2003, Milbury et al. 2006, Monagas2007). Procyanidins B1, B2, B3, and B4 and Prodelphinidins and propelargonidins have been identified in almond phenolics (Gu et al., 2003, Amarowicz et a.,l 2005, Shahidi et al., 2008)

Table 1 antioxidant compound (%) in Skin and Kernel of almond

Compound	Skin	Kernel
Catechin	35.7	8.8
Epicatechin	33.9	4.0
Quercetin-3-O-galactoside	41.4	Nd
Naringenin-7-O-galactoside	16.1	10.5
Quercetin-3-O-rutinoside	43.7	Nd
Quercetin-3-O-glucoside	*24.5*	Nd
Dihydroxyhaempferol	50.8	Nd
Kaempferol-3-O-galactoside	36.4	20.1
Isorhamnetin-3-O-rutinoside	35.0	3.2
Kaempferol-3-O-glucoside	39.0	16.6
Kaempferol-3-O-rutinoside	40.4	7.0
Isorhamnetin-3-O-rutinoside and glucoside	28.5	2.9
Eriodictyol	48.7	Nd
Quercetin	100	Nd
Naringenin	34.1	28.1
Kaempferol	100	Nd
Isorhamnetin	47.2	2.1

Source: **Siriwardhana et al., 2002.**

Antioxidation activity of Almonds

Antioxidation activities may be related to the presence of tocopherols, flavonoids and other phenolic compounds in nuts. Some of antioxidant component are showed in table1. Tocopherols were suggested the main antioxidant component of nuts in some researches (Yang et al., 2009), but it has been reported that the phenolic molecules to be a more effective antioxidant rather than tocopherol (Kırbaslar et al., 2012). Extracts of whole almond nut possess potent free radical scavenging capacity (Siriwardhana and Shahidi, 2002). The phenolic compounds of almonds act as antioxidants by scavenging free radicals and chelating metal ions in foods (Heim et al., 2002). Yanagisawa et al. (2006a) reported that almonds have DPPH radical scavenging ability, a prolonged lag time, and a suppression of lyso-PC production Yanagisawa et al., (2006a). In addition, cell-mediated LDL oxidation was suppressed after the treatment of whole almonds (Fukuda et al., 2005).

Yanagisawa et al. (2006b) reported that a modest quantity of almonds (56 g) in the diet each day for 4 weeks did not lead to an increase in the total cholesterol, LDL-cholesterol or apolipoprotein B levels, but led to a decrease in the malondialdehyde-LDL (MDA-LDL) levels.

Hyson et al. (2002) compared the effects of whole almond versus almond oil consumption on the LDL oxidation in healthy men and women, and reported that both treatments improved lipid parameters. A significant reduction in circulating oxidized LDL levels among asymptomatic adults was reported after consuming whole nuts in mixed diets at 50% walnuts, 25% almonds, and 25% hazelnuts (Fito et al 2007).

According to Ros 2009, the available evidence suggests that while PUFA-rich nuts confer a neutral or minimal effect on oxidative status, the effects of MUFA-rich nuts are more moderate. Moreover, chronic feeding studies using low PUFA nuts, including almonds, showed either an improvement in oxidation status or increased antioxidant enzyme activity. It is plausible that with less PUFA intake, the need to protect this oxidizable substrate is reduced and a higher proportion of the nut bioactives are available for other functions (Bolling 2010).

Mineral, vitamin E and arginine

Almonds are an important source of mineral, vitamin E, folate and L-arginin (Table.2).

Thirty grams of almond provides 7% of daily calcium needs. And also they contain the other Minerals such as iron, zinc, copper, magnesium, and potassium (Ros., 2010).

The major dietary sources of vitamin E are seeds, nuts and seed oils.). Nuts contain significant amounts of γ-tocopherol, almonds are especially rich in α-tocopherolα -tocopherol is the most active component of the Vitamin E and the most powerful antioxidant in the lipid (fat) phase of the human body and increasingly recognized as a relevant antiatherogenic molecule (Wagner et al 2004, Aiello et al., 2010, Gnanavinthan, 2013,). Jambazian et al (2005) found that almond intake to 20% energy significantly elevates plasma α-tocopherol status to 15%, respectively. Vitamin E is an important fat-soluble vitamin and antioxidant which can help maintain a healthy heart. The extremely critical role of α-tocopherol in protecting against free-radical reactions becomes apparent when considering the vast number of diseases (e.g. Senile dementia, Alzheimer and Atherosclerosis) thought to be caused by these reactions. Recent studies have also shown that a low vitamin E concentration in human blood is associated with an overall increased risk for many cancers, including breast and lung cancer (Gnanavinthan et al., 2013, Aiello et al 2010). Almonds have a high content of L-arginin amino acid which is converted to nitric oxide in the body. Nitric oxide causes blood vessels to relax and remain elastic, and helps prevent blood clotting. Sclerosis of the arteries and blood clotting can lead to heart disease (Ros 2009).

Table2 nutrient composition of almond (per 100g)

Nutrient	Composition
Plant sterol	120mg
Total protein	21.3g
Arginin	2.47
Fiber	8.8g
Folate	29µg
α-Tocopherol	25.9mg
Calcium	248 mg
Mangesium	275mg
Potassium	728 mg

Source: Ros2009

Proteins

Proteins comprise about 22 to 25% of the seeds, while 11 to 12% is represented by dietary fiber. Recent results have shown that the encapsulation of intracellular lipids by the cell walls restricts their digestion in the stomach and small intestine (Ellis et al., 2004, Mandalari et al., 2008a). Tree nuts are one of the eight major sources of food allergies and almonds are noexception. The major storage protein in almonds termed amandin or almond major protein (AMP) accounts for 65% of the total aqueous extractable seed proteins, and has been determined to be a major allergen in almonds. To date, evidence suggests that amandin is not as highly allergenic as the proteins found in peanuts or walnuts (Roux et al., 2001). [40]. Amandinis determined as a highly digestible protein and antigenically stable toward various food processing methods although it has poor nutritional value (Venkatachalam et al., 2006).

Dietary fiber

As Codex Committee “dietary fiber” definition includes plant cell walls, resistant starch, other non-starch polysaccharides and some non-digestible oligosaccharides; all of which are resistant to digestion and absorption in the human small intestine but usually with complete or partial fermentation in the large intestine (Cummings et al., 2009).

A prebiotic is defined as “a nondigestible food ingredient which beneficially affects the host by selectively stimulating the growth and activity of bacteria in the colon” (mandalari 2008b). And also in the other definition prebiotic is a selectively fermented ingredient that allows specific changes, both in the composition and/ or activity in the gastrointestinal microbial community that confers benefits upon host well-being and health'(Roberfroid, 1996). Thus they can balance the colonic microflora by their resistance to gastric acidity and are hydrolyzed by mammalian enzymes and gastrointestinal absorption. They are fermentable by intestinal microflora and cause selective stimulation of the growth and/or activity of intestinal bacteria associated with health and well-being (mandalari 2008b). The Prebiotic Index (PI) is a comparative relationship between the growth of beneficial bacteria and the less desirable ones, in relation to the changes of the total number of bacteria (Roberfroid, 1996).

Almond cell wall material contains pectic substances that are rich in arabinose, and the observation of their partial degradation by the gut microbiota in the fecal samples can be explained by the erosion of the middle lamella (Dourado et al., 2004, Ellis et al 2004). The bioaccessibility of nutrients and phytochemicals from almond seeds is improved by increased residence time in the gut and is regulated by almond cell walls. The results of studies have shown high amounts of lipid and protein remaining in the almond tissue after duodenal digestion and therefore available for fermentation in the colon by the gut microbiota (Mandalari et al., 2008a).

The effect of almond consumption on human Health

Heart healthy & cardiovascular benefits

Almonds contain about44-55.5 % fats, of which about 72.5-79.9% is monounsaturated oleic acid (an omega-9 fatty acid), 13.5-19.8% is linoleic acid (a polyunsaturated omega-6essential fatty acid), and 5.9-6.7%is palmitic acids (table3) (Venkatachalam et al., 2006, Ozcan et al., 2011).The acidity value of oils was found between 1.389 and 3.559%. In addition, peroxide values were established between 7.586 and 15.590 meq/kg (Ozcan et al., 2011).

Omega-3 and omega-6 PUFA are necessary to supply through daily dietary intake for health because they cannot be synthesized by the body (Aiello et al., 2010). Omega-3 fatty acids help to reduce the levels of triglycerides in the body and reduce the incidence of coronary artery disease (Venkatachalam & Sathe 2006). Oleic acids can help to reduce bad cholesterol (LDL) and to increase good cholesterol (HDL), plus has a low proportion of saturated fat (7% of total fat) and are free of trans fats. They also provide nutrients to help develop and maintain body's cells (Jenkins et al., 2002, Viguiliouk et al., 2014).

In addition researcher found that almonds in the diet for a month led to a reduction in oxidized LDL cholesterol which is damage to arteries (Jenkins et al., 2002).

Table 3 Averag Content (%) of Major Fatty Acid of Different Origins Almond (American, Italian, Spanish, Turkish, Tunisian cultivar)

Fatty Acid	
Palmitic acid C 16:0	5.03-7.5
Palmitoleic acid C 16:1	0.369-0.724
Stearic acid C 18:0	1.72-2.03
Oleic acid C 18:1	62.75-73.10
Linoleic acid C 18:2	11.87-20.45

Source: Awika et al., 2011

Effect on blood lipid profile

Almond not only has nutritional value, but also has beneficial effects on blood cholesterol level and lipoprotein profile in humans (Fukuda et al., 2005). It is reported that almond consumption significantly lowered total cholesterol and caused a significant reduction in plasma triacylglycerols, and LDL cholesterol with increased levels of HDL cholesterol in humans (Hyson et al., 2002, phung et al., 2009). On the other hand cholesterol-lowering effect of almonds compared with typical Western diets in healthy and hypercholesterolemic subjects was reported (Jenkins et al., 2002). Total and LDL-cholesterol concentrations declined with progressively higher intakes of almonds, suggesting a dose–response relation (Sabate et al., 2003). The decrease in total and LDL cholesterol observed was greater than those estimated from the fatty acid composition of the diets with the use of predictive equations. Thus nonlipid components of almonds may play a role in lowering serum lipids. Almond, as a part of a dietary approach, was found to be as effective as the starting dose of cholesterol-lowering drugs such as statins in managing cholesterol (Jenkins et al., 2002, Sabate et al., 2003).

Nuts can improve lipid profiles not only by the beneficial action of unsaturated fatty acids (PUFA and MUFA) but also may include the effects of fiber, micronutrients such as vitamin E and C, folic acid, copper, magnesium, plant protein (e.g., arginine), plant sterols, and phenolic components (Kris-Etherton et al., 2001) almond ingestion in a diet containing 50–100 g /d significantly decreased total cholesterol (between 4 and 16%) and LDL-C (between 7 and 19%) in hypercholesterolemic and normocholesterolemic subjects compared with subjects consuming a control diet (Jenkins et al., 2002, Sabate et al., 2003).

In other study, hyperlipidemic subjects consumed 50–100 g of almonds/d, and there was a significant 2% increase in HDL-C compared with those consuming a low-fat control diet (26 vs. 36%) (Jenkins et al., 2002). The almond diet decreased non-HDL-C and LDL-C compared with the control diet. In addition, the almond reduced HDL-C significantly less than the control diet (Mukuddem 2005).

Although nut is high in fat, it helps with weight control. One study of overweight adults who included 84g of almonds a day as part of a low-calorie diet showed those who ate almonds had a 62% greater weight loss compared to the control group (Wien et al., 2003). Furthermore, if undigested lipid from almond tissue reaches the large intestine, it could be used by resident microbiota, and evidence of bacterial fermentation was previously shown (Ellis et al., 2004).

In other study Total mass (ie, body weight), total fat mass, and total lean mass did not differ between treatments. The almond diet reduced abdominal mass and abdominal fat mass compared with the control diet. These findings were validated by weight contorol, which also decreased with the almond diet. In addition, almond consumption reduced leg fat mass (Berryman et al., 2015).

Hypoglycemic action

There are many researches and human trials that suggested a Mediterranean dietary pattern emphasizing nuts decreases in HbA1c (from 20.1% to 20.6% absolute reduction), fasting glucose, and the need for antihyperglycemic drugs (Viguiliouk et al 2014). [46]. It has seen that the more almonds that were added to the meal, the greater effect on blood glucose levels, and also the addition of almonds to a meal can reduce the rise in blood glucose which occurs after eating (Jenkins et al2006, Josse et al 2007). Improvements in other markers related to glycemic control, such as the adiponectin/leptin ratio, have also been reported, in addition randomized double-blind controlled trials and animal studies suggest Magnesium and MUFA play a key role in glucose metabolism (Viguiliouk et al 2014)

Reduces oxidative stress

A research of smokers found that almond consumption for one month reduced biomarkers of oxidative stress (Jenkins et al., 2006), while another found that eating almonds can enhance antioxidant defenses and has preventive effects on oxidative stress and DNA damage caused by smoking (Shahidi et al., 2002). Oxidation causes damage to the cells in our body and is believed to be an important factor in the development of diseases such as heart disease, cataracts and macular degeneration, as well as playing a role in ageing (Li et al., 2007).

Almond hull & shell

The Almond Hulls are the largest by-product of almonds by weight which are the outermost protective layer of the almond. They are a rich source of triterpenoids, betulinic, urosolic, oleanolic acids, lactones, as well as flavonol glycosides, phenolic acids, catechin, protocatechuic acid, vanillic acid and naringeninglucoside (Sang et al., 2002 Jahanban-Esfahlan et al., 2010).

And also isolation of a new prenylated benzoic acid derivative and three known constituents, catechin, protocatechuic acid, and urosolic acid from the hulls of almond were reported (Sang et al., 2002b). In addition about 4.5% of total hull weigh are phenolics, mainly tannins. The phenolics extraction that obtained from almond hulls showed remarkable radical-scavenging activities (DPPH) and antioxidant capacity almond hull extracts had higher antioxidant activity than α-tocopherol (Pinelo et al., 2004, Jahanban-Esfahlan et al., 2010). The water extraction of hulls and solvent extraction of shells to produce food ingredients and antioxidants, respectively, has been studied. Almond shell is highly lignified which is similar to that of hardwood (Quesada et al., 2002, Pinelo et al., 2004, Rabinowitz, 2004).

Antimicrobial activity

The antimicrobial properties of nut active compounds have been reported. Moreover in vitro investigation demonstrated that almond kernels have antitumor activity. Among a number of essential oils almond essential oils were found to be highly bactericidal rather than the other essential oils and in some instance significantly higher antibacterial activity from antibiotics i.e., tetracycline, ampicillin and ciprofloxacin (Gomaa 2013). Antimicrobial activity of almond oil to be more effective than grape seed oil, fuji apple seed oil and mulberry seed oil. Testing of almond oil on some species of microorganisms showed that it can inhibite Salmonella sp and B. subtilis higher than the other microorganism (Tian 2011). It has also stronge antimicrobial activity against E. coli (Gomaa 2013), Proteus vulgaris and Pseudomonas aeruginosa (Kırbaslar 2012).

According to kumar (2012) report almond oils have shown a significantly anti-candidal activity and their maximum activity was reported against C. guilliermondii kumar 2012). Polyphenols extracted from almond skins were effective in vitro against Helicobacter. Pylori, irrespective of genotype status and could therefore be used in combination with antibiotics as a novel method for antibiotic resistance (Bisignano et al 2013).

Conclusion

The roles of functional food in improving and maintaining human health have been studied extensively. Among the various nut of interest almond presents a nutritional and pharmacological value as a source of biologically active phytochemicals such as lipids, vitamins and minerals. It also has a significant amount of dietary fibers with a suitable prebiotic index. Moreover of nutritional value, almond significantly improves lipid profile in human that besides of those expected from its fatty acid composition. It has also capable to produce many beneficial effect on health (antidiabetes, anticarcinogen, prevent of fatness, etc). These outcomes may relate to a various bioactive compounds such as polyphenols, that existing in almond nuts, especially in its skin. Skin not only has antioxidant activity but also has significant amount of dietary and resistance fibers, that improve microflora gut and prevent colon cancer. It has antitumor and anticancer activities as well as antimicrobial activities. As a result we can define almond and its skin as an important functional food and more usage of it in food industry is a well-founded plan especially when it is not blanched.

References

Aiello G, La Scalia G, Cannizzaro L. (2010). Controlled temperature grinding under modified atmosphere for Almond (PrunusDulcis) paste production. International Journal of Engineering, Science and Technology.Vol. 2. No. 9. 69-82.

Aluko RE. (2011). Plant derived bioactives. In: Comprehensive Biotechnology, 2nd edn (ed. Murray M.-Y.), Academic Press, Burlington. PP.501–15.

Amarowicz R, Troszynska A, Shahidi F. (2005). Antioxidant activity of almond seed extract and its fractions. Journal of Food Lipids.Vol. 12. 244-358.

Awika J. (2011). Effect of bioactive components on dough rheology, baking and extrusion. In: Fruit and Cereal Bioactives (eds Tokusoğluö . and Hall C.). CRC Press. PP. 337–45.

Berryman CE, West SD, Fleming JA, Bordi PL, Kris-Etherton, PM. (2015). Effects of Daily Almond Consumption on Cardiometabolic Risk and Abdominal Adiposity in Healthy Adults With Elevated LDL-Cholesterol: A Randomized Controlled Trial. J Am Heart Assoc. 1-11.

Bisignano C, Filocamo A, Erminia La Camera E L, Zummo S, Fera M T Mandalari G.(2013) Antibacterial activities of almond skins oncagA-positive and-negative clinicalisolates of Helicobacter pylori. BMC Microbiology.Vol. 13. No.103.1-6.

Bolling BW, Chen CYO, McKay DL, Blumberg JB. (2011). Tree nut phytochemicals: composition, antioxidant capacity, bioactivity, impact factors. A systematic review of almonds, Brazils, cashews, hazelnuts, macadamias, pecans, pine nuts, pistachios and walnuts. Nutrition Research Reviews. Vol. 24. 244-275. doi: 10.1017/S095442241100014X

Bolling BW, McKay DL, Blumberg JB. (2010). The phytochemical composition and antioxidant actions of tree nuts, Asia Pac J Clin Nutr. Vol. 19. No.1. 117-123 .

Chen CY, Milbury PE, Lapsley K, Blumberg JB. (2005). Flavonoids from almond skins are bioavailable and act synergistically with vitamins C and E to enhance hamster and human LDL resistance to oxidation. J Nutr.Vol. 135. No. 6. 1366–1373.

Chen CY, Milbury PE, Chung SK, Blumberg J. (2007). Effect of almond skin polyphenolics and quercetin on human LDL and apolipoprotein B-100 oxidation and conformation. J Nutr Biochem.Vol.18. No. 12.785–794.

Chen CY, Blumberg JB. (2008). Phytochemical composition of nuts. Asia Pacific Journal of Clinical Nutrition. Vol.17. No. S1. 329 – 332.

Cummings JH, Mann JI, Nishida C, Vorster HH. (2009). Dietary fibre: an agreed definition. The Lancet. Vol. 31. No. 373. 365–366. doi: 10.1016/S0140-6736(09)60117-3.

Dourado F, Barros A, Mota M, Coimbra MA, Gama FM. (2004). Anatomy and cell wall polysaccharides of almond (Prunusdulcis D. A. Webb) seeds. J. Agric. Food Chem.Vol. 52.1364–1370.

Ellis PR, Kendall CW, Ren Y, Parker C, Pacy JF, Waldron KW, Jenkins DJ. (2004). Role of cell walls in the bioaccessibility of lipids in almond seeds. Am. J. Clin. Nutr. Vol. 80.604–613.

Emilio G. (2007). Detection and Isolation of bioactive natural products. In: Bioactive Natural Products (Colegate S.M. and Molyneux R.J.), CRC Press. PP. 11-76.

Fito M, Guxens M, Corella D, Saez G, Estruch R, de la Torre R, de la Torre R, Francés F, Cabezas C, López-Sabater Mdel C, Marrugat J, García-Arellano A, Arós F, Ruiz-Gutierrez V, Ros E, Salas-Salvadó J, Fiol M, Solá R, Covas MI. (2007) Effect of a traditional Mediterranean diet on lipoprotein oxidation: a randomized controlled trial. Arch Intern Med.Vol.167.1195-203.

Food and Drug Administration, Washington DC. US Food and Drug Administration (FDA). (2011) Guidance for Industry: A Food Labeling Guide [accessed June 4 2014]. Available from: http://www.fda.gov/food/guidanceregulation/guidancedocumentsregulatoryinformation/ labelingnutrition/ucm2006828.htm.

Food and Agriculture Organization (FAO), FAOSTAT Statistics Database (2011). Published online at: http://faostat.fao.org/site/340/default.aspx

Fukuda Y. and Nagashima M. (2005) Antioxidative Function of Seeds and Nuts and Their traditional Oils in the Orient. In Asian Functional Food (Shi J, Ho ChT, Shahidi F). CRC Press. 2005.381-410

Gnanavinthan A. (2013). Introduction to the Major Classes of Bioactives Present in Fruit. In: Bioactives in Fruit Health Benefits and Functional Foods (Skinner M. and Hunter D.). Wiley Blackwell. PP.1-18.

Gomaa EZ . (2013). In vitro Antioxidant, Antimicrobial, and Antitumor Activities of Bitter Almond and Sweet Apricot (Prunusarmeniaca L.)Kernels, Food Sci. Biotechnol.Vol. 22. No. 2. 455-463.

Gu L, Kelm MA, Hammerstone JF, Zhang Z, Beecher G, Holden J, Haytowitz D, Prior RL. (2003). Liquid hromatographic/ electrospray ionization mass spectrometric studies of proanthocyanidins in foods. J Mass Spectrom.Vol. 38.1272- 1280.

Harrison K, Were LM. (2007). Effect of gamma irradiation on total phenolic content yield and antioxidant capacity of almond skin extracts. Food Chem.Vol. 102. 932–937.

Heim KE, Taggliaferro AR, Bobilya DJ. (2002) Flavonoid antioxidants: Chemistry, metabolism and structure—activity relationships. J. Biochem. Vol.13. 575–584.

Hyson DA, Schneeman BO, Davis PA. (2002)Almonds and almond oil have similar effects on plasma lipids and LDL oxidation in healthy men and women. J Nutr. Vol. 132.703–707.

Jahanban-Esfahlan A, Jamei R,and Jahanban-Esfahlan R (2010) Review The importance of almond (Prunus amygdalus L.) and its by-products. Food Chemistry. Vol.120. 349–360.

Jambazian PR, Haddad E, Rajaram S, Tanzman J, Sabatè J. (2005). Almonds in the diet simultaneously improve plasma α- tocopherol concentrations and reduce plasma lipids. J Am Diet Assoc. Vol. 105. 449-454.

Jenkins DJ, Kendall CW, Marchie A, et al. (2002). Dose response of almonds on coronary heart disease risk factors: blood lipids, oxidized low-density lipoproteins, lipoprotein (a), homocysteine, and pulmonary nitric oxide: a randomized, controlled, crossover trial. Circulation.Vol. 106. No. 11.1327–1332.

Jenkins DJ, Kendall CW, Josse AR, et al. (2006). Almonds decrease postprandial glycemia, insulinemia, and oxidative damage in healthy individuals. J Nutr.Vol. 136. No. 12. 2987–2992.

Josse AR, Kendall CW, Augustin LS, Ellis PR, Jenkins DJ. (2007). Almonds and postprandial glycemia-a doseresponse study. Metabolism.Vol. 56. No. 3. 400–404.

Kırbaslar F G, Türker G, Özsoy-Günes Z, Ünal M, Dülger B, Ertas , Kızılkaya B. (2012). Evaluation of Fatty Acid Composition, Antioxidant andAntimicrobial Activity, Mineral Composition and Calorie Values of Some Nuts and Seeds from Turkey, Rec. Nat. Prod. Vol. 6. No. 4. 339-349.

Kris-Etherton PM, Zhao, G., Binkoski, A. E., Coval, S. M. Etherton, T. D. (2001) .The effects of nuts on coronary heart disease risk. Nutr. Rev. 59. 103–111.

Kumar A, Thakur S, Thakur VC, Kumar A, Patil S Vohra, MP. (2012). Antifungal Activity of Some Natural Essential Oils against Candida Species Isolated from Blood Stream Infection. JKIMSU. Vol. 1. No. 1. 61-66.

Li N, Jia X, Chen CY, et al. (2007). Almond consumption reduces oxidative DNA damage and lipid peroxidation in male smokers. J Nutr.Vol. 137. No. 12. 2717–2722.

Mandalari G, Faulks RM, G. T. Rich GT, Lo Turco V, Picout DR, Lo Curto RB, Bisignano G, Dugo P, Dugo G, Waldron KW, Ellis PR, Wickham MSJ. (2008). Release of protein, lipid and vitamin E from almond seeds during digestion. J. Agric. Food Chem. Vol. 56. 3409–3416 a.

Mandalari G, Tomaino A, Faulks RM, Arcoraci T, Bisignano G, Saija A, Wickham MS, Narbad A. (2008). Almonds (Amygdaluscommunis L.) as a possible source of prebiotic functional food The FASEB Journal.Vol. 22:698.1.b.

Mandalari G, Tomaino A, Arcoraci T, Martoranab M, Lo Turco V, et al. (2010). Characterization of polyphenols, lipids and dietary fibre from almond skins (Amygdalus communis L.). J Food Comp Anal.Vol. 23. 166-174 b.

Mandalari G, Bisignano C, D'Arrigo M, Ginestra G, Arena A, et al. (2010). Antimicrobial potential of polyphenols extracted from almond skin. LettApplMicrobiol.Vol. 51. 83-89 a.

Milbury PE, Chen CY, Dolnikowski GG, Blumberg JB. (2006). Determination of flavonoids and phenolics and their distribution in almonds. J. Agric. Food Chem.Vol. 54. No. 14. 5027–5033

Monagas M, Garrido I, Lebrón-Aguilar R, Bartolome B, Gómez-Cordovés C. (2007). Almond (Prunusdulcis (Mill.) D.A. Webb) skins as a potential source of bioactive polyphenols. J Agric Food Chem.Vol. 55.8498-8507.

Mukuddem-Petersen J, Oosthuizen W, and Jerling, JC. (2005). A Systematic Review of the Effects of Nuts on Blood Lipid Profiles in Humans. J Nutr. Vol. 135. 2082–2089.

Ozcan M M, Unver A , EsinErkan E, Arslan D. (2011). Characteristics of some almond kernel and oils, Scientia Horticulturae. Vol. 127. 330–333.

Phung OJ, Makanji SS, White CM, Coleman CI. (2009). Almonds have a neutral effect on serum lipid profiles: a meta-analysis of randomized trials. J Am Diet Assoc. Vol. 109. No.5. 865-873.

Pinelo M, Rubilar M, Sineiro J, Nunez MJ. (2004). Extraction of antioxidant phenolics from almond hulls (Prunusamygdalus) and pine sawdust (Pinuspinaster). Food Chem.Vol. 85.267–273.

Quesada J, Teffo-Bertaud F, Croue JP, Rubio M. (2002). Ozone oxidation and structural features of an almond shell lignin remaining after furfural manufacture. Holzforschung. Vol. 56. 32–38.

Rabinowitz IN. (2004). Dietary fiber, process for preparing it, and augmented dietary fiber from almond hulls.US Patent, US 0018255.

Ren Y, Waldron KW, Pacy JF, Brain A, Ellis PR. (2001) Chemical and histochemical characterisation of cell wall polysaccharides in almond seeds in relation to lipid bioavailability. In: Biologically-active phytochemicals in food: (Pfannhauser W. Fenwick GR. & Khokhar S.). Cambridge, United Kingdom: The Royal Society of Chemistry, pp. 448–452.

Roberfroid, M. B. (1996). Functional effects of food components and the gastrointestinal system: chicoryfructooligosaccharides. Nutr. Rev. Vol. 54. S38–S42.

Ros E.(2010). Health benefits of nut consumption. Nutrients. Vol. 2. No. 7. 652-682.

Ros E. (2009). Nuts and novel biomarkers of cardiovascular disease.Am J ClinNutr. Vol. 89. No. 5. 1649S–1656S.

Roux KH, Teuber SS, Robotham JM, Sathe SK. (2001). Detection and stability of the major almond allergen in foods. Journal of Agricultural and Food Chemistry.Vol. 149. 2131-2136.

Sabate, J, Haddad E, Tanzman JS, Jambazian P, Rajaram S. (2003). Serum lipid response to the graduated enrichment of a Step I diet with almonds: a randomized feeding trial. Am. J. Clin. Nutr. Vol. 77. 1379–1384.

Sang S, Cheng X, Fu HY, Shieh DE, Bai N, Lapsley K, Rosen RT, Stark RE, Ho CT. (2002). New type sesquiterpene lactone from almond hulls (PrunusamygdalusBatsch). Tetrahedron Lett. Vol. 43. 2547–2549, a.

Sang S, Lapsley K, Rosen RT, Ho CH. (2002). New prenylated benzoic acid and other constituents fromalmond hulls (PrunusamygdalusBatsch). J. Agric. Food Chem. Vol. 50. 607–609, b.

Shahidi F. (2002). Phytochemicals of almond and their role in inhibition of DNA niching and human LDL cholesterol oxidation. In: Abstracts of papers, 224th ACS National Meeting, Boston, MA, USA.

Shahidi F, Zhong Y. SSK Wijeratne. and C-T Ho. (2008). Almond and Almond Products: Nutraceutical Components and Health Effects. In: Tree Nuts: Composition, Phytochemicals, and Health Effects (Alasalvar C, Shahidi F.) 127-141. CRC press.

Shahidi F. (2009). Nutraceuticals and functional foods: Whole versus processed foods. Trends in Food Scienceand Technology.No. 20, 376–87.

Siriwardhana SSKW, Shahidi F. (2002). Antiradical activity of extracts of almond and it's by-products. J. Am. Oil Chem. Soc. Vol. 79. No. 9. 903–908.

Tian H, Zhang H, Ping Zhan P, Tian F. (2011). Composition and antioxidant and antimicrobial activities of white apricot almond (Amygdaluscommunis L.) oil, Eur. J. Lipid Sci. Technol. Vol. 113.1138–1144.

Venkatachalam M, Sathe SK. (2006). "Chemical composition of selected edible nut seeds". Journal of Agricultural and Food Chemistry.Vol. 54 No, 13. 4705–4714.

Viguiliouk E, Kendall CWC, Mejia S B, Cozma AI, Ha V, Mirrahimi A, Jayalath VH, Augustin LSA, Laura Chiavaroli L, Leiter LA, de Souza RJ, David JA, Jenkins DJA, Sievenpiper JL.(2014) Effect of Tree Nuts on Glycemic Control in Diabetes: A Systematic Review and Meta-Analysis of Randomized Controlled Dietary Trials. PLOS ONE. Vol. 9. No.7. 1-13.

Wagner KH, Kamal-Eldin A, Elmadfa IU. (2004). Gamma-tocopherol an underestimated vitamin? Ann Nutr Metab. Vol. 48:169–88.

Wijeratne SSK, Amarowicz R, Shahidi F. (2006). Antioxidant activity of almonds and their by- products in food model systems. J. Am. Oil Chem. Soc. Vol. 83. No. 3. 223–230,b.

Wien MA, Sabate JM, Ikl DN, Cole SE, Kandeel FR. (2003). Almonds vs complex carbohydrates in a weight reduction program. Int J ObesRelatMetabDisord.Vol. 27. No. 11.1365–1372.

Wijeratne SSK, Abou-Zaid MM, Shahidi F. (2006). Antioxidant polyphenols in almond and its coproducts. J. Agric. Food Chem.Vol. 54. No. 2. 312–318, a.

Yang J, Liu RH and Halim L . (2009). Antioxidant and antiproliferative activities of commonedible nut seeds, LWT Food Sci Technol. Vol. 42. 1-8.

Yanagisawa C, Uto H, Tani M, Kishimoto Y, Machida N, Hasegawa M, Yoshioka E, Kido T,Kondo K. (2006) The antioxidant activities of almonds against LDL oxidation.XIV InternationalSymposium on Atherosclerosis, Rome, Italy, June 18–22, Abstract # We P14.395.p-434 a.

Yanagisawa C, Uto H, Tani M, Kishimoto Y, Machida N, Hasegawa M, Yoshioka E, Kido T,Lapsley KG, Kondo K. The effect of almonds on the serum lipid, lipoprotein and apolipoproteinlevels in Japanese male subjects.XIV International Symposium onAtherosclerosis, Rome, Italy June 18–22, Abstract # We-P14:396, p-434, 2006b.