PHYTOCHEMISTRY, NUTRITIONAL AND MEDICINAL IMPORTANCE OF ALMOND

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Summary: Almond belongs to the Rosaceae family commonly known as Prunus dulcis. Almond kernel extract contains phytochemicals as well as fatty acids, phenolic acids, phenolic compounds, flavonoids, phytosterols and vitamins. The major fatty acids were linoleic acid (15.43%) and oleic acid (76.23%). These outcomes show that almond extraction is a rich source of fatty acids, soluble lipid vitamins, phytosterols, flavonoids, phenolic compounds. Moreover, these results are important in the science of nutrition, because these chemicals seem to have a significant health effect. Almond kernel has high nutritional value, these days, they are in required as a nutritious food with progressive growth in population. Research on a composition of almond micro- and macronutrients has shown that nuts contain many nutritious components like lipids, amino acids, carbohydrates, minerals, vitamins, proteins, and secondary metabolites. Clinical studies have confirmed the effects of almond kernel on fatty acid variation, protective effects of diabetes, role of weight control, metabolic syndrome and cardiovascular disease. The current review is designed to highlight the significance of almonds kernel as a nutritious food source, as well as to explore factors that contribute to the quality of almond seed.

Keywords: almond, phytochemicals, nutrients, disease treatment

INTRODUCTION

The kernel of the almond plant is termed as Prunus dulcis, a member of a family Rosaceae with genus Prunus L., cultivated in Mediterranean climate, including the Australia, central Asia, and California (United States) Mediterranean, native to south-central Asia [55]. Almond kernels contain diverse amount of amygdalin, diglucoside reduced to benzaldehyde and hydrogen cyanide in response to crushing of kernel and exposure to water or saliva [54]. Cultivated almonds varieties grown show a distinct chemical profile because of environmental portion, genetic portion, and processing conditions. Up taking of almond nut regularly

has always been linked to beneficial outcomes, mainly in cardiometabolic disorder [14].Clinical trials and epidemiological studies have reported benefical influence of nut use compared to a specific number of pathalogies such as high blood pressure, diabetes, obesity and metabolic syndrome [5, 47]. Prunus amygdalus L. comprises of carbohydrates, protein, calcium, fats, iron, phosphorus, oxalic acid, thiamine, sulphur, copper, iodine, and chlorine [1]. Almond is considered a potent source of tocopherols (vitamin E), lipids (monounsaturated and polyunsaturated) and arginine [45]. All forms of almond are being used by consumers. They are mostly consumed as snacks and are used in making variety of sweets and spicy dishes. Techniques used for almond's processing include: roasting, blanching, particle size reduction and oil extraction. Roasting is a heating process which cause dehydration of almond [23]. Blanching is done to reduce contamination caused by microbial growth. These thermal techniques used dry and wet method to remove skin of almond. Blanching reduce the nutritional quality of almonds because it involve removal of skin which contain essential phenolic constituents and flavonoids. Moisture content of blanched almond is higher, when compared to roasted almond. Roasted and blanched almond can be processed further to reduce their shape and size. After that other methods involving solvent extraction (SE) and supercritical fluid extraction (SCFE) are being used for the extraction of almond oil [53]

Dry matter content of fresh almond seed is relatively higher that is around 97 to 98 percent and is mainly composed of carbohydrates, protein, fiber, ash, mineral etc. Because of low starch and high protein content, it can be incorporated into cookies and cake for diabetic patient [46]. In addition, it is a rich source of essential minerals, vitamin E, dietary fiber, mono-unsaturated fats, vitamins B and phytosterols containing cholesterol lowering substances. They are also useful in treating various skin diseases such as eczema and acne [40].

FIGURE 1. Almond Seeds on Plant
https://4.imimg.com/data4/HS/WH/MY-1238623/almond-plant-500x500.jpg

PHYTOCHEMISTRY

The seed of the almond tree is 3-5.5 cm wide and 5-7 cm in length, green at first, then yellow and finally red when ripe. The fruit contain a single seed, which is a tasty edible snack eaten by children and snacks and there have been no reports of toxicity associated with its use [36]. It is also a fruit with a thick grey and green outer shell called a hull. It has been shown to be a nutritious food that provides more than 20% of the daily amount of niacin, calcium, vitamin E, riboflavin, magnesium, iron, phosphorus, manganese, and zinc per 100 g each [7]. The group of Almond is comprised of two varieties, namely Prunus Amara (bitter almond) and Prunus dulcis (sweet almonds). Almond oil is obtained mainly from sweet almonds, which contain about 50% oil. This extraction is made commercially by solvent extraction and cold press [50].

Almond plants are major resource of essential antioxidants that include vitamin C, tocopherols, phenolic compounds and carotenoids. These chemical was developed as suitable compound in case of oxidative stress due to their high degradation function [49].

Although free radicals and other forms of oxygen is persistently produced in the human body, the imbalance between antioxidants and oxidants, yields oxidants, which is related to oxidative stress and is involved in a few human disorders. Considering their functioning properties, natural antioxidants are promoted as molecules that expand the timeframe of realistic usability of items in the food business. Natural antioxidants are used for this purpose instead of synthetic antioxidants (for example butylated hydroxyanisole and butylated hydroxytoluene). **Figure 3** shows the bioactive chemical in kernel and its by-products [4, 6, 39, 43].

FIGURE 2. Parts of Almond fruit
https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.mdpi.com%2F1420-3049%2F22%2F10%2F1774%2Fhtm&psig=AOvVaw21Q6trpH4R24StbP_1GejP&ust=1610047808563000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCNiRhpa0ie4CFQAAAAAdAAAAABAJ

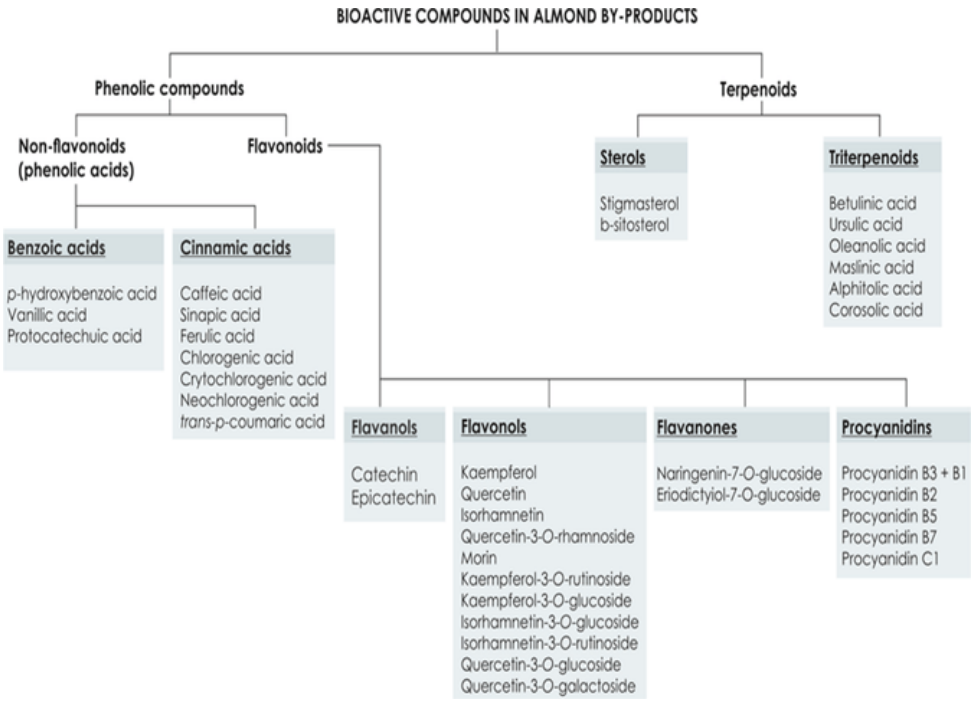

FIGURE 3. Bioactive chemicals in almond by-products
https://www.researchgate.net/publication/320562479/figure/fig2/AS:552618563178496@1508765940206/Bioactive-compounds-in-almond-by-products-Bioactive-compounds-in-almond-by-products.png

PHENOLIC COMPOUNDS

A phenolic compound is a large group of phytochemicals in Prunus dulcis. The class of chemical compounds consisting of one or more hydroxyl groups bonded directly to an aromatic ring, and categorize as flavonoid and non-flavonoid chemicals. The flavonoids class is made up of aurones (4a), flavones (4b), flavanones (4c), flavanols (4d), flavonols (4e), anthocyanins (4f), and chalcones (4g), and the non-flavonoids (phenolic acids) mainly include benzoic and cinnamic acids (5a and 5b, respectively) [15, 22].

FLAVONOIDS

Flavonoids are pigments which are soluble in water, consists of two phenyl rings that are joined by three carbon atoms forming oxygen containing heterocyclic compound [35]. These phenolic compounds are synthesized in the form of phenylpropanoid, in which 4-coumaroyl-coenzyme A is formed by phenylalanine,

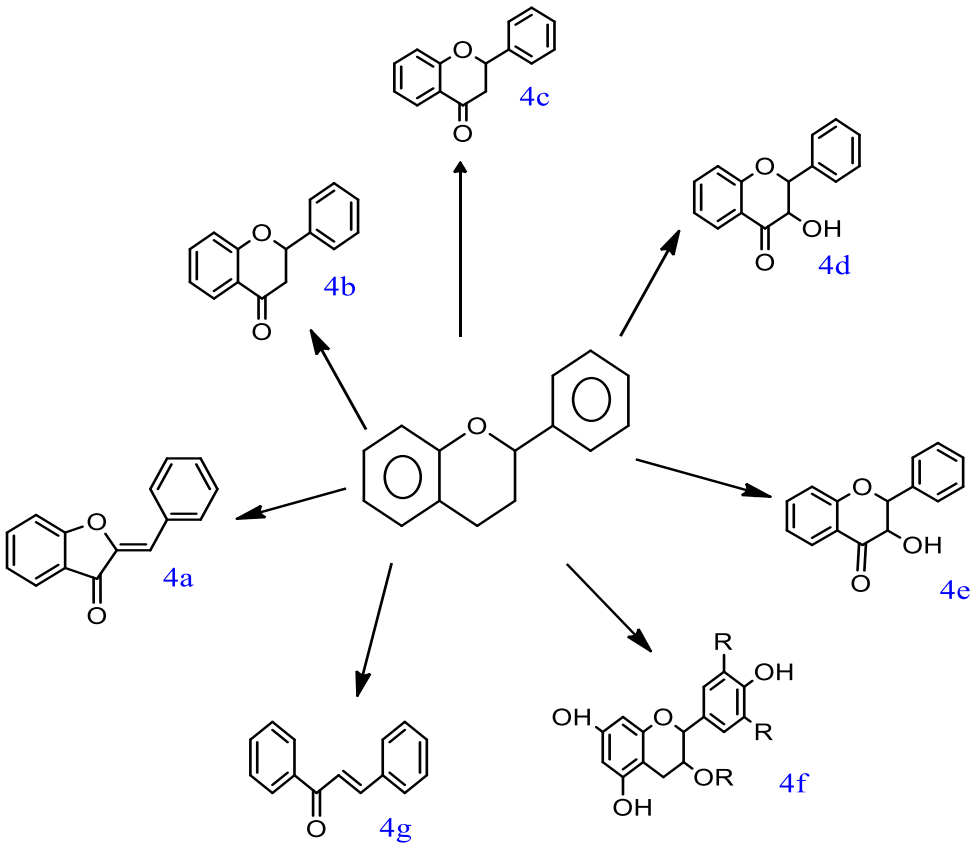

FIGURE 4. Structure of flavonoids class

and then enters the flavonoid in biogenesis pathway. The biological functions of flavonoids in plants are related to protection against UV rays, bacterial infections, pollination nodulation [17], flower pigmentation and symbiotic nitrogen fixation, act as chemical agents, regulators and cell cycle inhibitors [26]. In almond tree, flavonoids are in a form of glycosides and aglycones [20]. The formation of flavonoids in plants is affect by many factors like UV radiations, environmental conditions, geographical origin, pest and disease exposure, agricultural practices, storage, processing and maturation stage [38].

PHENOLIC ACIDS

Phenolic acid is the second metabolite characterized by aromatic hydroxylated rings. Hydroxycinnamic acids and hydroxybenzoic are manufacture by shikimic acid in the normal phenylpropanoid form. However, apart from the lengthy study of the chemical and biological functions of phenolic acid, to date, these data are

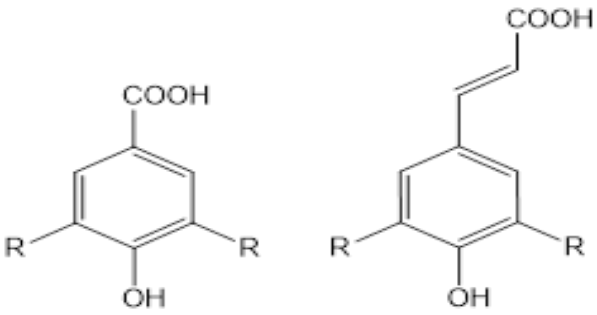

FIGURE 5. Structure of non-flavonoids class

still lacking, and there are limitations to their ability to measure biological activity in trees. However, the biological purpose of phenolic acid is associated with nutrient uptake, protein synthesis and photosynthesis [41].

NUTRITIONAL IMPORTANCE

The plant continues to transform the face of the earth with the unique benefits they offer around the world. Almond seeds form an important part of the human food and their importance, especially in the diet of the developing world, is increasing for a number of reasons [3]. Almond seeds are an excellent source of edible oils, fats and protein in foods and immature industries in local industries. The seeds are also used by many rural residents in South Nigeria to supplement local food, which is often low in protein [13].

ALMONDS AS A SOURCE OF ENERGY AND MACRONUTRIENTS

Almonds typically contain around 575 kcal per 100 g and about 50% fat. However, the lipid compositions of almonds are beneficial because monounsaturated fatty acids (MUFA) are high and the saturated fat content (3.7 g per 100 g almonds) is lower than all nuts. Total fat contains 62% MUFA and 24% polyunsaturated fatty acids [12, 42, 52]. Fatty acids from almonds plays an important role to the health benefits of regular nut use, namely reduced risk of sudden cardiac death, heart disease, lowering blood cholesterol, preservation or strengthening of low density lipoprotein (LDL) resistance to chemicals and improving the function of endothelial [21, 42]. In almond the whole protein content is 21.2%, making them a rich source of plant protein, and the proteins in almonds are high in arginine [2]. Almond kernel contain approximately 3.9 g of whole sugar per 100 g, and

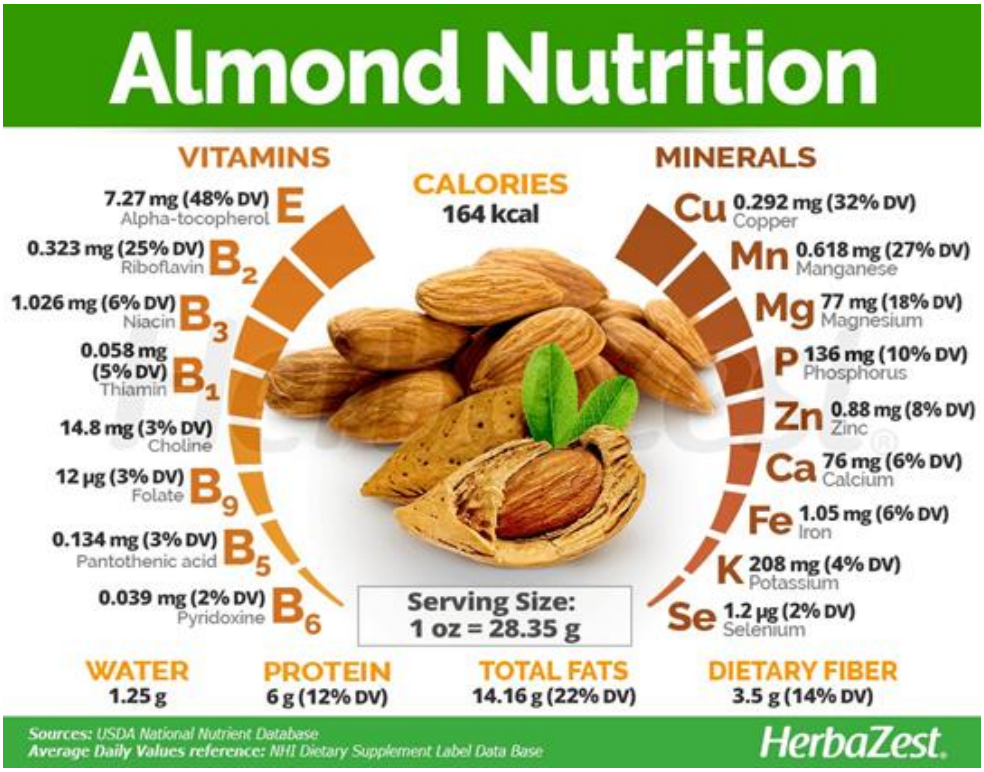

FIGURE 6. Almond nutrition

because they contain less than 5 g sugar per 100 g can be described as 'naturally low sugar' under the new European regulation on Nutrition 1924/2006 regarding food requests and health [33].

The quantity of nutrients in almonds relies on the origin and variety. Additionally to many amino acids and fats, bitter almonds contain minerals, such as Zn, Ca, Mg, Zn, Fe, K, and vitamins, especially vitamin E [32]. The Bitter almond kernel contains about 60% carbohydrates, 30% protein, 3% amygdalin, 48% fat, and other nutrients [10]. Moreover, according to a study on the bitter almond properties, the almond kernel contains 94.84% of its unrefined oil and 49.6% fat. Moreover, the seed was found to contain 26.72% amino acids (17 total amino acids), 7.57% essential amino acids and 27% protein [31]. The lipid of the almond seed are linoleic acid (20.68%) and oleic acid (70.61%). Almond seed acid is an important source of vitamin K (42.25 mg/kg), lipid-soluble vitamins [vitamin D (1.40 mg/kg), fatty acids (92.15 mg/kg) and saturated fatty acids (7.85 mg/kg) [28]. Bitter almond has a huge quantity of supplements [29].

TABLE 1. Nutrients and mineral composition

NUTRIENTS	VALUE PER 100 G WHOLE ALMOND	UNIT	MINERALS	VALUE PER 100 G WHOLE ALMOND	UNIT
Calories	579	Kcal	Calcium	269	mg
Water	4.41	g	Iron	3.71	mg
Protein	21.15	g	Magnesium	270	mg
Lipids	49.93	g	Phosphorus	481	mg
Dietary fiber	12.5	g	Potassium	733	mg
Sugar	4.35	g	Sodium	1	mg
Ash	2.97	g	Zinc	3.12	mg
			Copper	1.03	mg
			Manganese	2.18	mg

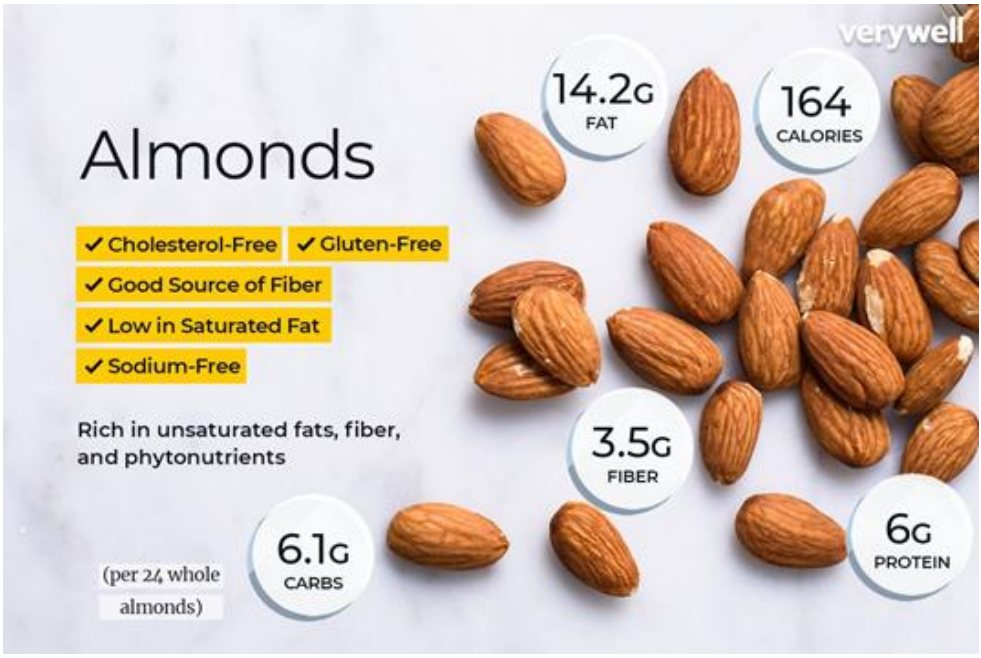

FIGURE 7. Almond nutrition facts
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MEDICINAL IMPORTANCE OF ALMOND

The almond is a popular nutritious food, rich in healthy fats, protein, minerals and vitamins. It also has medicinal value used for treating various diseases. The seeds of prunus amydalus possess various pharmacological properties such as anti-stress, anti-oxidant, immune stimulant, lipid lowering and laxative. Almonds are an effective dietary supplement for blood loss, as they contain iron, vitamins and copper [40].

PHYTOSTEROLS AND ANTIOXIDANTS

Tree nuts, including almonds, contain no dietary cholesterol but are good in chemical-related phytosterols, a group of chemicals that interfere with the absorption of cholesterol and thus help maintain healthy blood cholesterol levels. The most abundant phytosterols in plants are b-sitosterol, campesterol, stigmasterol and 5-avenasterol. The reduction in cholesterol in the production of nuts in human studies has often been more than predictable on the basis of the exchange of fatty acids and high MUFAs content. Phytosterols in nuts may be responsible for part of this effect [21].

FIGURE 8. Almond Medical Properties
https://www.herbazest.com/herbs/almond

REDUCED RISK OF CARDIOVASCULAR DISEASE

Epidemiological studies have been surprisingly inconsistent in demonstrating the link between nut use and lower possibility of CHD [18, 30, 44]. Observational studies have shown a median reduction in CHD mortality of 37% (low risk (RR) ¼ 0.63, 95% confidence interval (CI): 0.51, 0.83) or a reduced 8.3% reduction in CHD mortality risk per week each of the nuts [37]. The positive effects of almond use are similar to different clinical outcomes: sudden cardiac death, myocardial infarction, and fatal CHD. Taken together, these epidemiological findings provide strong evidence of cardioprotective benefits of nut use [44].

WEIGHT MAINTENANCE

Epidemiological studies suggest that those who eat nuts regularly (five times every seven days) tend to have lower body mass indices [9, 19, 52]. These observations led to research on almonds to understand potential mechanisms of weight loss and weight maintenance. Almond seeds are high in protein and fiber and have a low blood glucose index [24].

EFFECT ON DIABETES AND GLYCEMIC CONTROL

Population with Diabetes Mellitus are at greater possibility of developing cardiovascular diseases and intake of almonds can help high risk population against cardio vascular diseases [27]. Scientists observed 35 patients in 42 week with metabolic disorder and type 2 diabetes (diabetes mellitus) using almonds with high protein, high fat (40% fat, 25% protein and 22% MUFA (monounsaturated fatty acid) in diets. The result showed the control in glycemic index was normalized in all 10 patients, 12 patients were dropped out in first week and weight loss was observed. Thus, controlled diet can be a synonym with heart healthy diet. Clinical intervention shows that almond can improve markers other than serum lipids with diabetes mellitus and had also intervention with the risk of cardio vascular disease. Blood glucose control is critical for anticipation and management of diabetes mellitus [34, 48].

Low blood glucose index foods have been shown to be fruitful in increasing insulin sensitivity to prevent high amount of insulin in blood [27]. Almond consumption governs satiety and can improve HDL (high density lipoprotein) in blood, thereby, improving cognitive function [8, 14, 51]. Scientists studied 137 participants with increased risk of type 2 diabetes. There was a greater decrease in the feeling of hunger and serum glucose concentration to the population that consumed almond at snack time and also despite of taking almond there was no weight gain [14]. In another study by [11], 29 parents and 29 children's consumed almonds, 1.5 ounce per day. It was reported that almonds promote cognitive function, and energy restricted over weight for obese adults. Recent study showed memory increase in obese children and improvement in diet quality [16].

LIPIDEMIC CONTROL

The positive results of up taking of almond regularly are to regulate lipid level in blood. Random controlled meta-analyzes describe an association between almond reduction and a consumption in low-density lipoprotein cholesterol (LDL-c) and total cholesterol (TC), but, no significant results have been notice with respect to high-density lipoprotein cholesterol (HDL-c), triglycerides (TG) or LDL-c/HDL-c ratio [25].

CONCLUSION

We have discussed the phytochemical profile, nutritional importance, and medicinal importance of almond kernel, a famous and essential medicinal plant with a long history of use. Almonds deliver a massive amount of nutrients they are the edible seeds of Prunus dulcis, they are loaded with antioxidants and are a fantastic source of antioxidants. The almond nuts are rich in proteins, fat, vitamins (vitamin E, vitamin K), carbohydrates, minerals (magnesium, copper, etc.) and various bioactive compounds (polyphenols, phytosterols, etc.) and are utilize as natural antioxidant activities. Regular taking of nuts would be linked with reduced the risk of several disorders, as well as diabetes mellitus, hypertension, metabolic syndrome, obesity and cardiovascular diseases.

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