



*Review article*

## The Importance of FattyAcids in Nuts in Terms of Human Health <sup>a</sup>

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### ABSTRACT

People's eating habits have undergone radical changes over time. The correlation between people's eating habits and the diseases has been widely reported in many studies. Therefore, people pay great attention to their diet for a healthy life. Proteins, lipids, and carbohydrates, which play a significant role in human nutrition, are the most important energy sources for the survival of living organisms. Nuts such as hazelnuts, almonds, walnuts, and pistachios contain substantial amounts of lipids, in the form of mono and polyunsaturated fatty acids, which have demonstrated numerous beneficial effects for human. In general, the fatty acids found in nuts are an important dietary component for a healthy and balanced diet. Nuts are high in energy value and rich in nutritional content. To improve nutritional diversity and health, it is essential to consume nuts in the daily recommended amounts. In the study, information about the importance of fatty acids found in nuts for nutrition and human health is included.

**Keywords:** Fatty acids, Health, Nut, Nutrition

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## **Sert Kabuklu Meyve Türlerinde Bulunan Yağ Asitlerinin İnsan Sağlığı Açısından Önemi**

### **ÖZ**

İnsanlar zamanla beslenme alışkanlıklarında köklü değişikliklere gitmişlerdir. Yapılan birçok araştırmada, insanların beslenme alışkanlıkları ile karşılaştıkları hastalıklar arasında bir ilişki olduğunu ortaya koymuştur. Bundan dolayı günümüze baktığımızda, sağlıklı bir yaşam sürdürmek isteyen insanlar beslenmelerine dikkat ettiği görülmektedir. İnsanların beslenmesinde önemli bir yer tutan protein, lipitler ve karbonhidrat yaşayan organizmaların yaşamını devam ettirmesi için en önemli enerji kaynaklarıdır. Fındık, badem, ceviz ve Antep fıstığı gibi meyveler, yüksek miktarda lipit içerirken, bu lipitlerin tekli ve çoklu doymamış yağ formunda olması bu meyvelerin insan sağlığı için birçok yararlı etkilerini ortaya çıkarmıştır. Genel olarak baktığımızda sert kabuklu meyvelerde bulunan yağ asitleri sağlıklı ve dengeli beslenmede önemli bir diyet grubu içerisinde yer almaktadır. Sert kabuklu meyveler enerji değeri yüksek ve besin içeriği yönünden de oldukça zengindir. Besin çeşitliliğinin ve sağlığın iyileştirilmesi yönünden sert kabuklu meyveler günlük önerilen miktarlarda tüketilmesi önemlidir. Çalışmada sert kabuklu meyve türlerinde bulunan yağ asitlerinin insan beslenmesi ve sağlığı açısından önemine dair bilgilere yer verilmiştir.

**Anahtar Kelimeler:** Beslenme, sağlık, sert kabuklu meyveler, yağ asitleri.

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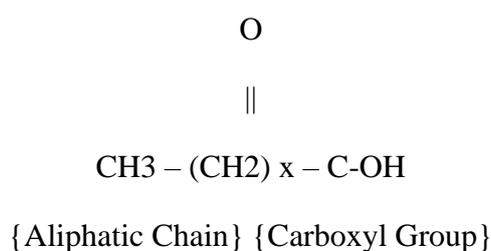
### **Introduction**

Nutrition is the science that investigates the factors related to the substances that living things take from the foods they assimilate in order to maintain their vital activities. In this context, when examined the science of nutrition is considered as a branch of biochemistry. This branch of science examines various biochemical processes necessary for the continuity of life, the formation of the structure that makes up living organisms, and the chemical structure of foods that provide the necessary energy (Eris and Yanmai, 1979). Nutrition is provided by the intake of nutrients in our body, and none of the nutrients can meet the body's needs. Therefore, for a balanced diet, it is imperative to choose various foods with different shapes, colors, and flavors (Erkut, 1969). Although most energy is provided by fats, fatty acids are specifically saturated. Furthermore, they are rich in complex carbohydrates, fiber, protein, tocopherol, non-sodium minerals, and polyphenols. Presently, many fruit and vegetable species come to the fore thanks to their high content of highly unsaturated fatty acids, antioxidants, vitamins, and minerals that affect human health. Hence the number of studies conducted on this subject is on the rise (Maguire et al. 2004; Jambazian et al. 2005). The significance of fruits rich in oleic, linoleic, and linolenic fatty acids has positive effects on cholesterol level regulation and cardiovascular diseases in humans. In order to create a healthy and sustainable nutrition policy, countries that try to cope with chronic environmental problems such as rapidly increasing population, global

warming, and climate change prioritize the prevention of diseases over their treatment. In this regard, one of the solutions proposed by science is to increase the consumption of functional components or foods with physiological effects. In addition to their known nutritional values, functional components are defined as “substances that have positive physiological effects on the human body depending on their composition”. Numerous studies have found a relationship between nut consumption and cardiovascular protection and are therefore recommended as a component of a healthy diet.

### **Fatty acids**

Oil is a complex structure that is insoluble in water but soluble in organic solvents such as ether, benzene, and chloroform (Ozdemir, 2003). Fats and oils fall in the group of compounds dominated by triglycerides consisting of glycerol and fatty acids. The physical and chemical structures of lipids are dictated by the composition of the fatty acids they contain. Due to these features, it is used in many industries. Although glycerol is present in the same composition in all oil plants, fatty acid composition differs according to plant types (Baydar, 2000). The carboxyl group (-COOH) in the fatty acid is the most valuable element of the oil. Fatty acids with double carbon atoms and a carboxyl group are the most dominant fatty acids in oils (Kayahan, 2003; Nas et al. 2001). Fats, which have high energy values, also constitute important building blocks of cells due to essential fatty acids and vitamins in their structure (Koroglu and Koksall, 1998). Fatty acids have an even number of carbon atoms on a regular basis. These fatty acids are straight chain derivatives consisting of double carbon units. Lipids, like proteins, are important substances that must be taken as part of the daily diet of people. The daily fat requirement of a person is 50-70g which is recommended to be supplied from both animal and plant-based foods. However, in some cases, animal fats are completely cut in terms of health and daily fat needs are met from vegetable oils (Tayar and Korkmaz, 2004).



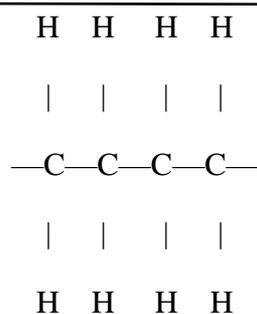
**Figure. 1.** The general formula of fatty acid.

### **Classification of fatty acids**

Fatty acids found in oils are generally straight-chain derivatives and are classified into two types: saturated and unsaturated fatty acids.

#### **Saturated fatty acids (SFA)**

Fatty acids that consist of a single covalent bond (-C-C-) between carbon-carbon atoms (Nas et al. 2001), and are generally solid at room temperature are called saturated fatty acids. Fats rich in these fatty acids are also called saturated fats (Fig. 2).

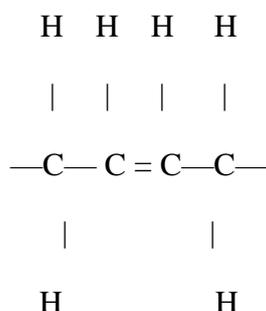


**Figure 2.** Carbon atoms in the saturated fatty acid chain.

Lauric acid (C12:0), Myristic acid (C14:0), Palmitic acid (C16:0), Stearic acid (C18:0), Aracidic acid (C20:0) and Behenic acid (C22:0) found in vegetable oils are the most important saturated fatty acids. Palmitic and stearic acids are the most dominant saturated fatty acids, especially in vegetable oils. Saturated fatty acids synthesized in the human body, even if no fat is consumed, can be synthesized from molecules formed by carbohydrate metabolism (Kumeli, 2006).

### Unsaturated fatty acids (UFA)

Fatty acids with one or more carbon-carbon double covalent bonds at various positions in the carbon chain are called unsaturated fatty acids (Fig. 3). Fats that are rich in these fatty acids are called unsaturated fats (Nas et al. 2001).



**Figure 3.** Carbon atoms in the unsaturated fatty acid chain

Due to the double bonds in their structure, unsaturated fatty acids are more reactive than saturated fatty acids. This reactivity increases with the number of double bonds in the fatty acid chain (Nas et al., 2001). Unsaturated fats are essential fatty acids that the body needs. They are in a liquid state at room temperature and most of them are of vegetable origin (Kumeli, 2006). Unsaturated fatty acids cannot be synthesized by the human body and, therefore, must be obtained through dietary sources (Mol, 2008). Various studies conducted in recent years have emphasized the importance of unsaturated fatty acids and essential amino acids in human nutrition (Erkan and Ozden, 2007).

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### **Monosaturated fatty acids (MFA)**

Fatty acids with a double bond in their structure are called monounsaturated or monoenoic fatty acids. Two important members of this group are oleic acid (C18:1) and palmitoleic acid (C16:1). Although palmitoleic acid is commonly a characteristic component of marine animal oils, oleic acid has been found in all known natural oils to date (Kayahan, 2003). Monounsaturated fatty acids are present in high ratios in olive, rapeseed oils, nuts (hazelnuts, pistachios, walnuts), nut oils (peanut oil and almond oils), and avocado (Kumeli, 2006).

### **Poly unsaturated fatty acids (PUFA)**

Fatty acids containing more than one double bond are called PUFA. Linoleic (C18:2), linolenic (C18:3), arachidonic (C20:4), eicosapentaenoic (C22:5) and docosahexaenoic (C22:6) acids are the most important polyunsaturated fatty acids. From a nutritional standpoint, polyunsaturated fatty acids are important essential fatty acids and are also called vitamin F. It is demanded that these fatty acids be present in certain amounts in various oil products (Nas et al. 2001).

### **Importance of fatty acids for human health**

Nuts are called “foods containing functional components” because they contain adequate levels of nutrients needed on a daily basis, regulate appetite, supply calories, and are effective in preventing and treating especially cardiovascular diseases and some cancer diseases (Martins et al. 2017; Martirosyan et al. 2017). Regarding cardiac diseases, there are numerous studies underlining the relationship between healthy life and fatty acids. (Connor, 2000; Kolanowski and Laufenberg, 2006), reported that the risk of heart diseases and heart attack is closely related to EPA and DHA. Moreover, pointed out that these acids (EPA and DHA) ensure the healthy functioning of the cardiovascular and immune systems (Lauritzen et al. 2001). In addition, it has been observed that EPA reduces the cholesterol level, delays the formation of atherosclerosis, and significantly reduces the risk of heart attack by preventing thrombosis in the vessels. The benefits mentioned above are supported by epidemiological studies (Erkan and Ozden, 2007). Nuts, produced in different ecological conditions contain high levels of vitamins and minerals, are rich in oil and protein components, and are a food group consumed from past to present. The most edible nuts are pistachios (*Pistachia vera*), almonds (*Amygdalus communis*), walnuts (*Juglans regia*), hazelnuts (*Corylus avellana*), cashews (*Anacardium occidentale*), pine nuts (*Pinus pinea*), pecans (*Carya illinoensis*), Brazil nuts (*Bertholletia excelsa*), Macadamia nut (*Macadamia integrifolia*) and Queensland nut (*Macadamia terni folia*) (Del Castillo et al. 2018; Ersan and Topcuoglu, 2019).

### **Composition and nutritional values of nuts**

Nutrient and mineral contents of nuts are given in table 1, fatty acid contents in table 2 and table 3.

**Table 1.** Nutrients and mineral contents of nuts (100/g FW)

Nuts	Protein (g)	Oil (g)	Carbohydrate (g)	Energy (kcal)	Dietary fiber (g)	Ca (mg)	Fe (mg)	P (mg)	K (mg)	Na (mg)
Hazelnut	12.6	61.0	16.7	634	3.0	209	3.4	337	704	2
Walnut	14.8	67.8	15.8	651	2.1	99	3.1	380	450	2
Almond	18.6	54.0	19.5	598	2.6	234	4.7	504	773	4
Pistachio	19.3	44.4	19.0	594	1.9	131	7.3	500	972	-

**Table 2.** Fatty acid contents of nuts (g/100g FW).

Nuts	Saturated fatty acids	Monosaturated fatty acids	Polysaturated fatty acids
Hazelnut	4.60	49.09	6.00
Walnut	5.59	14.18	39.13
Almond	4.95	33.90	10.96
Pistachio	6.69	35.66	7.99

**Table 3.** Specific fatty acid content in nuts (g/100g FW).

Nuts	Myristic 14:0	Palmitic 16:0	Palmitoleic 16:1	Stearic 18:0	Oleic 18:1	Linoleic 18:2	Linolenic 18:3	Arachidic 20:0
Hazelnut (Karaosmanog lu 2021)	nd	4.63	0.11	2.54	83.67	8.66	0.15	0.13
Walnut (Muradoglu ve ark 2010)	0.04	4.04	0.36	1.66	21.81	60.51	11.51	0.07
Almond (Celik and Balta 2011)	0.47	7.24	0.55	1.93	72.60	17.39	0.11	0.08
Pistachio (Adal 2015)	nd	9.20	0.68	2.01	70.14	17.34	0.18	nd

Nd: Not detected

### Pistachio

Pistachio, due to its protein, fat and fatty acid, vitamin, antioxidant, and mineral contents, is a rich source for human nutrition (Tayar and Korkmaz, 2004). The fact that pistachio fruit provides a high amount of energy compared to most fruit types has led to the recognition of pistachio as an energy source among people. Michael et al. (Michael et al. 2006), reported that pistachio is a fruit rich in protein and dietary fibers and that 28 g of pistachio in daily nutrition meets 13% of the recommended protein amount and 12% of dietary fibers. Also, pistachios are rich in protein and minerals compared to walnuts, hazelnuts, and beef. According to the researchers, when compared to hazelnuts, almonds, walnuts, peanuts and pine nuts, pistachios bear the least amount of energy (557 kcal), the highest level of protein after almonds (20.6 g/100 g) and higher fiber, phytosterols, gamma-tocopherol, xanthophyll carotenoids and vitamin K (Tayar et al. 2011). When compared to oil seeds such as almond, hazelnut and walnut,

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pistachios rank first in terms of protein, carbohydrates, vitamins A, B1, B6 and E, beta-carotene, lutein, iron, total phytosterol and potassium contents (Kucukoner and Yurt, 2003). In terms of oil content, pistachios hold the last place (44.4%) among the nuts (Shi and Shahidi, 2010). It has been determined that people who frequently consume nuts have 19-29% less heart disease rate than people who consume very little with a risk of death less than 17% (Zhou et al. 2004). Studies have shown that hazelnut, almond, pistachio, and walnut consumption increases the daily lipid/lipoprotein profile (Griel and Kris-Etherton, 2006). Furthermore, there are studies underlining that pistachio consumption has curative qualities (Kalkanci et al. 2007), and protects against diseases as a function of its numerous biological activities (Surh, 2003).

### **Pistachio and fatty acids**

Tokusoglu, (2007), revealed that the presence of a high amount of arginine amino acid in the composition of pistachio protects the arterial dilating feature and vascular flexibility thereby promoting increasing the blood flow rate. Kepekci et al. (1991), reported that the antioxidant, flavonoids, vegetable protein and unsaturated fatty acids in the structure of pistachio regulate carbohydrate tolerance, increase postprandial blood sugar, and prevent diabetic complications. Since pistachio is a nutrient with a low glycemic index, it helps to maintain the feeling of satiety and lowers blood glucose concentrations after eating which reduces the risk of diabetes. Kendall et al. (2014), reported in their study that the glucose level was high after the consumption of foods rich in carbohydrates, whereas the glucose level was low in the carbohydrate foods taken after the consumption of pistachios. Although nuts contain a large amount of fat and are high-energy foods, it has been observed that fruit consumption does not contribute to weight gain or obesity (Bes-Rastrollo et al. 2007; Casas-Agustench et al. 2011). Studies have shown that people who consume pistachios frequently have lower weight while those who consume less have a lower body mass index (Cotton, 2004). Pistachios, with their high monounsaturated fatty acid contents, are an important source of unsaturated fatty acids that reduce the risk of coronary heart disease (Kris-Etherton, 1999). It has been stated that the consumption of pistachios significantly reduces oxidative stress by regulating total cholesterol and LDL levels in healthy individuals (Kocyigit et al. 2006; Kasliwal et al. 2015), found that individuals consuming pistachio regularly both improved glycemic and lipid parameters, and also caused improvements in atherosclerosis and endothelial function. In addition, it has been observed that the phytosterols found in pistachios prevent prostate cancer. Orhan et al. (2006), in their study on the pistachio plant, they determined that the resin of the plant has an inflammatory effect and painkiller properties, but they observed that these effects were absent in some parts of the plant. It has been reported that pistachio resin has an important role in the treatment of several diseases. Since pistachio has antioxidant properties, it protects cardiovascular health, prevents some types of cancer, and reduces bad cholesterol by eliminating the factors that cause cancer. Lutein and zeaxanthin, which are found in all nuts only in pistachios, are concentrated in the retina, which is thought to act as a blue light filter to protect tissues against phototoxic effects (Carpentier et al. 2009). Sarı et al. (2010), examined the effects of pistachio consumption on inflammation, lipid parameters, endothelial function, and oxidative status in their study, and stated that low-density lipoprotein of *Pistacia vera* L. reduced, triacyl glycerol, glucose, and total cholesterol. In addition, the consumption of pistachios which contain a rich vitamin and

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mineral content is especially recommended for the healthy physical and mental development of children (Yahia, 2011). Pistachio contains a significant amount of Zn and Se minerals, which have antioxidant effects that play a role in the prevention of cardiovascular diseases and various types of cancer (Hercberg et al. 2010; Huang et al. 2006). Selenium, which is essential for human health, is effective in preventing cancer (Alberg and Samet, 2003). Lutein and zeaxanthin have been proposed as important factors in the pathophysiology of age-related macular degeneration (SanGiovanni et al. 2012). Pistachio is very rich in phenolic compounds; therefore, it has been reported that it has protective and inhibitory effects against diseases associated with high production of free radicals such as cancer and cardiovascular diseases (Hassellund et al. 2013). The essential oils of the fruit and leaves of Pistacia species also have antibacterial and antifungal properties (Tsokou et al. 2007).

## **Walnuts**

In ancient times, many plants were likened to human organs and used in the treatment of emerging diseases. Walnuts, which hold a significant place among fruits, have been used medicinally for the treatment of various diseases, including brain diseases, memory enhancement, emotional balance, mood regulation, and the improvement of certain skin disorders. Especially in Asian countries, walnuts are still consumed as food for the brain (Ergun and Sutyemez, 2008). It has been stated that the walnut kernel has stone-breaking and diuretic properties enabling kidneys to dislodge stones and is good for asthma, chronic cough and anemia, prevents vomiting during pregnancy, and is used as a fattener and sedative. In addition, the oil obtained from walnut is utilized in the treatment of colitis pain and menstrual irregularities, hair dryness, dandruff and head wounds. The fruit peel of walnut boiled in water is good for intestinal inflammation and fungal diseases. The green shell of the walnut relieves anemia, stomach inflammations, abscesses, eyelid inflammations, kills head and body lice and intestinal worms, and is also used in the treatment of acne and herpes. In addition, it is stated that walnut leaves are also utilized in reducing hand and foot sweating (Yigit et al. 2005). Stevens et al. (1995), reported that approximately 60% of the human brain consists of structural fats, and that the brain needs these fats, especially omega-3 fatty acids, in order for the brain to function in a healthy manner. Epidemiological studies have proven that there is a relationship between depression, attention deficit, hyperactivity and brain nerve dysfunction in children and the rate of omega-3 consumption (Stevens et al. 1996). In addition to reducing the risk of cardiovascular diseases, walnuts balance cholesterol and provide a healing effect. Walnut, which has an important place in human health, contains mostly monounsaturated fats and is rich in polyunsaturated fatty acids such as omega-3 and omega-6, which are an important part of our daily fat requirement. In this context, when walnuts are examined in terms of fatty acids, the linoleic acid content was determined to be the highest (50.24–60.60%), followed by oleic acid (20.70–28.33%) and linolenic acid (10.93–15.04%), respectively (Amaral et al. 2006). Cancer, one of the most dangerous diseases of our time, arises as a result of uncontrolled growth and proliferation of cells (Anonymous, 2022a). Reiter et al. (2005), stated that due to its antioxidant composition, walnuts have the properties of minimizing the risk of cancer, delaying or slowing the progression of resistant diseases such as Parkinson's and Alzheimer's, which damage the cardiovascular and nervous system. The hormone Melatonin is the hormone that

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helps regulate the human biological clock rhythm and is effective in ensuring the sleep pattern of a person (Anonymous, 2022b). This hormone, which is necessary for the human body, is present in walnuts. The secretion of this hormone decreases with age, and this decrease not only causes sleep disorders but also increases the diseases related to free radicals, which are probably caused by antioxidant deficiency. Furthermore, the consumption of walnuts is believed to increase the melatonin level in human blood and eliminate sleep disorders (Reiter et al. 2005). In a study conducted on 80.000 women, it was observed that for a period of 120 years, women who consumed 30 g of walnut kernels per week had a 25% less risk of developing gallstones than those who did not. In the same study, the researchers reported that they could not explain the reason behind such phenomenon and that the data obtained was likely to stem from the oil profile of the walnut, phytosterols or the mineral magnesium (Tsai et al. 2004). The scientific community stated that they were surprised by the similarity between walnuts and the brain, and the relationship between the basic components in walnuts and the vitamins that the brain needs (Anonymous, 2022d). Scientists have stated that the relationship between walnuts and the physical structure of the brain, as well as the similarity of nutrients in walnuts and vitamins needed by the brain, is surprising (Anonymous, 2022c). Simsek (2015), stated that silver, an element present in the human brain can only be found in walnuts and that it is necessary for the healthy functioning of the human brain and positively affects the development of intelligence in children.

### **Walnuts and fatty acids**

A group of organic compounds which are contained in walnuts are important for a healthy life and have an oxidation inhibitory effect. These compounds, which are present in the composition of walnuts, are polyphenols of ellagitannins and are known as glansrin A, B and C. It has been determined that these important compounds have antioxidant effects, and they prevent the oxidation of LDL and eliminate its harmful effects. In other words, they prevent the occurrence of atherosclerosis (Fukuda et al. 2003). In a study, it was determined that walnut is a fruit rich in polyunsaturated fatty acids,  $\alpha$ -tocopherol and many other important tocopherols. Maguire et al. (2004), reported that walnuts are a healthy food source because they contain  $\beta$ -sitosterol and stigmasterol in their structure. Feldman (2003), found that a diet containing walnut oil reduced LDL cholesterol and carbon-reactive protein levels and this in turn indicates a decrease in vascular occlusion and heart diseases. The FDA (American Food and Drug Administration) recommended that people consume 30 g of walnuts daily to reduce heart diseases due to their unsaturated fat content (Tarantino, 2004). Tapsell et al. (2004), performed an experiment on two groups of patients and determined that the HDL cholesterol level increased compared to the total cholesterol in the patients who were given walnuts compared to the patients who were not given walnuts, and a 10% decrease was observed in LDL cholesterol. A field survey of three groups of people with different consumption patterns (Never, Sometimes, Often) of walnut oil was conducted to investigate the impact of walnut oil on the cholesterol levels of these groups. The result concluded that walnut or walnut oil consumption increased HDL cholesterol and lowered LDL cholesterol. Also, the study reported that there was no change in total cholesterol level of people with low walnut oil consumption (Sometimes) while the increments were registered in people with a frequent consumption pattern (Lavendrine et al.

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1999). Munoz et al. (2001), determined that walnut diet reduces LDL cholesterol in individuals with high cholesterol. Elaine and Feldman (2002), stated that walnuts have a protective effect against coronary heart diseases. Ros et al. (2004) found in their experiment that walnut diets had a more pronounced effect on cholesterol, which lowered systolic and diastolic blood pressure compared to main diets. Since walnuts are rich in monounsaturated fats, a decrease in high cholesterol and other cardiovascular risk factors has been observed in humans when taken regularly and in sufficient amounts (Sawage et al. 1999). For example, omega-3 fatty acids present in the walnut composition prevent irregular heart rhythm, promote the production of blood groups with very little coagulation properties in the veins and increase the amount of high-density lipoprotein (HDL) cholesterol compared to the amount of low-density lipoprotein (LDL) cholesterol (Tapsell et al. 2004). Omega-3 fatty acids contribute to the reduction of swelling and redness, which are important signs of cholesterol at the stage of occlusion of the arteries (Morgan et al. 2002). In a study conducted on a group of people, it was stated that consuming 4 walnuts daily significantly increased the levels of omega-3, alpha-linoleic acid (ALA) and eicosapentaenoic acid (EPA) in the blood. In another study, it was found that consuming a few walnuts a day improved the protective omega-3 levels in the blood of adult people (Marangoni et al. 2007). Simsek (2015), stated that consuming an average of four walnuts per day is very beneficial for human health. As a result of their clinical research, (Almario et al. 2001). Anderson et al. (2001), emphasized that the fibres and unsaturated fatty acids in walnuts affect the regulation of plasma fats by lowering the concentration of cholesterol and triacylglycerol in the blood and that the protective effect of walnuts on heart health stem from the high amount of polyphenol and fatty acid profile in walnuts. Carrero et al. (2004), emphasized that the polyunsaturated fatty acids in the composition of walnuts have an anti-inflammatory and antihypertensive effect in preventing cardiovascular diseases and that they reduce the amount of fat in the blood, and prevent thrombosis and vascular occlusion. Also, they underlined the essentiality of Omega 3 and Omega 6 as fatty acids and that they must be taken with food because they are not produced by the body. Numerous studies have shown that many problems arise related to omega-3 fats. The foods we consume daily, except for walnuts and fish, cannot meet the need for omega-3 fats in general for our body. Researchers have reported that most of the population, even in the USA, is deficient in omega-3 fatty acids (Zhou et al. 2014). Recently, clinical and scientific studies have stated that the effect of walnuts on health is more than just a rumor. Studies indicate that walnuts may have much more potential than many of the positive effects mentioned above. Therefore, walnuts are perhaps the most important foods that should be added to the daily diet of people of all ages for a healthier lifestyle.

### **Almond**

Nowadays, the issue of living a healthy life and nutrition is gaining importance day by day. Consumers prefer value-added foods with high nutritional properties and physiological benefits. Scientific studies on both consumer expectations and the effect of nutrition on health, in particular the healing properties of some fruits and vegetables have highlighted functional products in this area. In addition to the protein, vitamin, and mineral substances in the almond composition, it is among the important fruits as it contains high levels of unsaturated fat

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(Gradzie et al. 2001; Kafkas et al. 1995; Zacheo et al. 2000). Kodad et al. (2004), reported that almonds contain high amounts of monounsaturated fatty acids (oleic acid), low amounts of saturated fatty acids (palmitic and stearic acids), and polyunsaturated fatty acids (linoleic acid). Ahrens et al. (2005), emphasized that almonds are a rich source of nutrients and have a high nutritional value, as well as having great significance across the world due to their beneficial effects on human health. Kodad et al. (2004), stated that the main unsaturated fatty acids found in almonds are oleic and linoleic fatty acids and they have the property of lowering cholesterol in the blood. In addition, almonds contain high amounts of phenol and tocopherol (Kornsteiner et al. 2006). Since alpha and gamma tocopherols are powerful antioxidants, they can take part in conducting different tasks in human health. The only difference lies in their chemical structure. Alpha-tocopherol is found in higher amounts in the body. Recent studies have revealed that gamma-tocopherol has a protective effect against prostate and colon cancer (Jiang et al. 2006), while alpha-tocopherol significantly reduces the progression of the risk of developing bladder cancer. In the Middle East, sweet almond oil (*Prunus dulcis* L.) is widely cultivated as a dietary nutrient due to its rich composition. Almond oil is considered a good soothing oil by aromatherapists as it is very light, sweet, and aromatic. In addition, thanks to the components in its structure, it is also used in cosmetic products. However, due to the high amount of unsaturated fatty acids in its composition, it is prone to rapid oxidation. Almond oil is a rich source of alpha-tocopherol. Almond consumption is associated with the improvement of hypertension, hyperlipidemia, hyperglycemia, and obesity. In a twelve-week clinical trial conducted on 20 Chinese patients, almond consumption was ruled out to improve glycemic control and lower the risk of diabetes type 2 and cardiovascular disease. A total daily calorie intake of 20% was added to the control diet. Daily consumption of 60 g of almonds showed an increase in dietary intakes of fiber, magnesium, polyunsaturated fatty acids, monounsaturated fatty acids, and vitamin E. The body fat of patients consuming almonds was determined to be lower as a result of bioelectrical internal resistance analysis. The almond diet increased the alpha-tocopherol level by 26.8% when compared to the control diet. In addition, almond intake reduced total cholesterol (6%;1.6-9.4%), low-density lipoprotein cholesterol (11.6%; 2.8-19.1) and the ratio of low-density lipoprotein cholesterol to high-density lipoprotein cholesterol (9.7%; 0.3-20.9%) (Li et al. 2011).

### **Almond and fatty acids**

Recently, studies on the effect of almonds on lowering blood cholesterol and lowering the risk of heart disease have increased significantly. Due to its high content of fatty acids, dietary fiber, phenolic components, B group vitamins (B, B2, B6) and potassium, and low sodium content, almonds have been found to have a positive effect on the improvement of many ailments such as cholesterol, cardiovascular diseases, weight control, diabetes, anxiety and Alzheimer's. It has also been proven by numerous studies that it bears anti-inflammatory, antioxidant, anticarcinogenic, and prebiotic properties (Batoool et al. 2016; Batoool et al. 2018; Gorji et al. 2018; Hou et al. 2018; Martins et al. 2017; Tsai et al. 2004; Williams et al. 2019). Almond (*Prunus dulcis* L), a nutritious food has been extensively investigated in recent years on their potential health benefits, and its use has been associated with weight control as well as lowering the risk of chronic diseases such as coronary heart disease (CHD) and type 2 diabetes. Almonds

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have gained popularity in the diet of mankind since ancient times as a snack. Although approximately 50% of the weight of almonds is fat, an increased intake of 7 g of almonds daily reduces the concentration of low-density lipoprotein (LDL) cholesterol by 1%, as specifically stated in the diets recommended by the National Cholesterol Education Program. The usual consumption of almonds does not lead to weight gain, and their inclusion in low-calorie diets results in greater weight loss than a similar carbohydrate-based low-calorie diet. Also, almonds have a low glycemic index and do not adversely affect insulin sensitivity. Almonds are a bioavailable source of tocopherols, and increasing their intake increases LDL's resistance to oxidation. In addition, the polyphenolic components of almonds have been recently characterized and found to have antioxidant effects (Chen et al. 2016). Almonds are rich in monounsaturated fat, fiber, minerals such as  $\alpha$ -tocopherol, magnesium and copper, and phytonutrients, although they are energy-dense. Appropriate fat composition and fiber contribute to the hypocholesterolemic benefit of almond consumption. Thanks to their unique nutritional composition, almonds provide benefits against other modifiable cardiovascular and diabetes risks such as body weight, glucose homeostasis, inflammation, and oxidative stress (Kamil et al. 2016). Almonds can help reduce high cholesterol and low-density lipoprotein (LDL) cholesterol levels, as well as increase the level of high-density lipoprotein (HDL) cholesterol. It has also been stated that almonds are beneficial for hyperglycemia (Demir and Yılmaz, 2014; Dong et al. 2010). Studies conducted on nuts in Australia, Canada, Israel, India, New Zealand, and the USA showed significant reductions in total cholesterol (7-25%) and LDL cholesterol (10-33%) (Ternus et al. 2009). In recent years, there have been many studies on the positive effects of almonds in the prevention or treatment of many diseases such as cardiovascular, diabetes, body weight, inflammation, and oxidative stress. Studies have shown that regular consumption of almonds and other nuts has a positive effect on the prevention of cardiovascular diseases. This positive effect of almonds is associated with its high content of dietary fiber, potassium, magnesium, tocopherols, phytosterol, polyphenolic components and unsaturated/saturated fat. Although almonds are known for their unique fatty acids, about 14% of their energy comes from protein, hence they are also a good source of protein. Since almonds have the highest dietary fiber content among the nuts, approximately 14% of the daily recommended dietary fiber amount can be met with a single serving of almonds. Since insoluble fibers reduce intestinal transit time and increase satiety, they can also have a positive effect on reducing the amount of low-density cholesterol (LDL). In addition, almonds contain phytosterols that prevent intestinal cholesterol absorption. In studies carried out, it has been determined that consumption of 100 grams of almonds per day reduces the rate of total cholesterol and low-density cholesterol (LDL), which is a risk factor for coronary heart disease (Gorji et al. 2018; Kalita et al. 2018; Kamil and Chen, 2012; Martins et al. 2017; Richardson et al. 2009; Williams et al., 2019). In recent years, studies have focused on the importance of almonds in glycemic control, reducing insulin sensitivity and diabetes risk factors. It has been reported that especially the dietary fiber, magnesium, vitamins, minerals and antioxidants in the composition of almonds cause a lower glycemic index and prevent the development of Type 2 diabetes (Chen et al. 2017; Hou et al. 2018). Almond DNA has a high content of  $\alpha$ -tocopherol and polyphenols, which have strong antioxidant effects that protect lipids and proteins from oxidation. Almond antioxidants with different properties work either as regulators of radical scavenging or endogenous antioxidant systems, or with both influences, an antioxidant defense

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capacity. Almond antioxidants with different properties work synergistically, either by scavenging radicals or regulating endogenous antioxidant systems, or by increasing antioxidant defense capacity with both effects. Due to the effect of almond components on glucose, the formation of glucose-based radicals thus oxidative damage can be reduced. Polyphenols such as flavonoids in the composition of almonds and flavonols and flavonolglycosides in the thin peel can contribute to the increase of antioxidant defense by modulating endogenous antioxidant systems or acting as antioxidants (Kendall et al. 2010; Martins et al. 2017). It is known that mono and polyunsaturated fatty acids in the composition of almonds prevent the formation of gallstones. Dietary fiber, magnesium, phytochemicals, and antioxidant vitamins may also support gallbladder health. For example, dietary fiber reduces the recirculation of bile acids in the intestine, while phytosterols reduce dietary cholesterol absorption (Tsai et al. 2004). Almonds have been reported to be effective in the treatment of dry throat, viral infections, peptic ulcers, help relieve urinary retention, show aphrodisiac properties, and give positive results in the improvement of urticaria and skin lesions. In addition, almonds constitute an important food group in the diet of celiac patients because they do not contain gluten (Gopumadhavan et al. 2003; Khalid et al. 2017).

### **Hazelnut**

One of the main goals in the development of healthy living habits is the acquisition of healthy eating habits. Improvement of individual diet and health practices along with increasing the efficiency of health services reduces the contraction of preventable diseases, disabilities, and premature deaths (Baysal, 1999). Hazelnut, thanks to its oil and unsaturated fatty acids, protein, carbohydrates, vitamins, minerals, dietary fiber contents, is an oilseed that can be included in meat group foods, which are very important for human nutrition and health. Almonds do not contain cholesterol and possess antioxidant properties. It contains vitamin E, which has antioxidant properties and is included in the food group that reduces the risk of cancer (Anonymous, 2023a; Baysal and Criss, 2004). In addition to providing energy in the organism, fats have important functions such as maintaining body temperature, protection against external factors and transporting fat-soluble vitamins. Furthermore, there are fatty acids in the composition of oils, which have various functions and benefits in the organism (Baysal, 1999). In studies on the composition of hazelnut oil, it has been determined that it resembles olive oil in composition and that there is the highest amount of oleic fatty acids in all varieties, followed by linoleic, palmitic, stearic, and linolenic fatty acids, respectively (Ozdemir et al. 2001; Simsek and Aslantas, 1999). The high level of oleic acid provides oil resistance (Yalcin and Unal, 2002). Nutrients in hazelnuts are of great importance in terms of nutrition. 100 g of hazelnut gives 634 calories of energy. 2.8-7.9% of the dry matter in hazelnut is total sugar. Sucrose constitutes 90% of the total sugar. Glucose and fructose have a share of 1%. Starch constitutes 1-3.6% of the dry matter. Nuts are rich in nutrients and contain high levels of protein, fat, vitamins, and minerals. Hazelnuts contain incredible health benefits that support brain health, weight loss, healthy muscles, bone health, and nervous system and prevent cancer, and neural damage. Malic acid is the most organic acid in hazelnuts. Cellulosic compounds and pectin constitute 1-3% of hazelnuts. The protein content of hazelnut kernels varies between 10-24%. 100 g hazelnut kernels provide 22% of a person's daily protein needs. Due to the high content

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of unsaturated fatty acids in hazelnuts, it has a positive effect on the cardiovascular system and prevents the rise of cholesterol in the blood and has a protective effect against cardiovascular diseases. The majority of fatty acids are oleic and linoleic acids. Oleic acid reduces the level of cholesterol in the blood, and linoleic acid has an inhibitory effect on vasoconstrictions. Hazelnut is the second-best source of vitamin B1, B6 and natural antioxidant vitamin E after other vegetable oils. With the consumption of 100 g hazelnuts, 33% of the daily need for vitamin B1, 35% of vitamin B6 and 24% of vitamin E can be met. In addition, hazelnut is a type of fruit rich in amino acids. For a balanced and healthy diet, daily consumption of 100 g of hazelnut is very useful (Anonymous, 2023b). In addition to being a great source of fiber, they contain large amounts of monounsaturated fatty acids that help reduce LDL cholesterol (good cholesterol) and increase HDL cholesterol (bad cholesterol). Magnesium, phosphorus, and potassium are minerals associated with diabetes prevention. Hazelnuts provide a good combination of these minerals, which is beneficial for anyone suffering from diabetes. It supports good cholesterol and reduces bad cholesterol. Nuts, along with walnuts, are considered nutrients for the brain. They contain beneficial fats, proteins and amino acids that aid cell regeneration and support healthy brain functions. The combination of vitamin E, vitamin K, thiamine and selenium found in hazelnuts tremendously improves the brain. It may also be useful in preventing diseases such as Alzheimer's because it improves memory and brain activity. Hazelnuts are a delicious source of antioxidants; they contain vitamin E, which has effective properties in reducing the risk of lung, breast and prostate cancer. The array of antioxidants that hazelnuts have is very helpful in fighting oxidative stress, which is largely responsible for cancer formation. Nuts are rich in thiamine and selenium. Antioxidants such as lutein and zeaxanthin can aid in the establishment of strong immunity and fight cancer symptoms. Loss of bone density can lead to serious inflammatory diseases such as arthritis and joint pain. Hazelnuts are high in calcium, potassium, magnesium, and phosphorus, which are essential minerals that keep bone density intact as people age. Manganese helps build stronger bones and prevents the onset of osteoporosis in women. There are networks of nerves running through the body. It helps produce myelin to keep the system healthy enough. Myelin is the sheath of these nerves. This is necessary to ensure that electrical signals are transmitted throughout the body and brain. Hazelnuts not only promote internal health, but also help maintain the healthy appearance of the skin. There are many vitamins and minerals in hazelnuts that support heart health. Hazelnut is a rich source of vitamin E and vitamin C. These vitamins are considered the cornerstones of skin care and their combination with fatty acids makes them the most beneficial food for healthy and glowing skin.

### **Hazelnut and fatty acids**

In recent studies, it has been shown that regular consumption of hazelnuts as part of a healthy diet reduces the risk of CHD development in healthy individuals, as well as decreasing heart attack (acute myocardial infarction) and cardiac deaths due to CHD (Albert et al. 2002; Ellsworth et al. 2001). Studies have shown that oleic acid prevents the rise of cholesterol in the blood, lowers cholesterol by 26.2%, regulates blood sugar, has a protective effect against cardiovascular diseases, and increases apoprotein A-1 which has a protective effect against heart diseases, by 28%, and decreases the formation of risky apoprotein by %7.5 (Anonymous,

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2023c; Parcerisa et al. 1998). Linoleic acid prevents the precipitation of platelets in the blood and narrowing of the vessels. Even this feature alone reveals that linolenic fatty acid should be given importance in daily diets in terms of healthy nutrition. It is known that the linoleic and linolenic fatty acids in hazelnut oil have an effect on lowering blood lipid and triglyceride levels, thus blood pressure, and can synthesize prostaglandins, which have functions of reversing cardiovascular diseases. In some trials, a diet rich in linoleic acid were applied to diabetic patients who did not need insulin and those who followed a diet with high levels of fat, and it was observed that triglyceride, cholesterol and insulin levels in the blood decreased after 10 days (Parcerisa et al. 1998; Yalcin and Unal, 2002). Antioxidant and phytochemical substances in hazelnut and hazelnut oil have an inhibitory effect on the development of many chronic diseases such as diabetes (cancer, atherosclerotic heart diseases, cataracts, etc) (Anonymous, 2023b; Anonymous, 2023c), by preventing cell destruction by free radicals and increasing body resistance (Baysal et al., 2002). In a study by Alphan et al. (1996), at the end of two diets containing the same amount of fiber, it was found that while the fasting insulin level increased by 21% in the hazelnut-containing diet, there was no change in the postprandial insulin and there was a significant decrease in Hb A<sub>1</sub>C levels (Elmacioglu et al. 2000). Another important feature of hazelnut oil is that it does not contain cholesterol, which is known to play a role in the emergence of cardiovascular diseases. In addition, b-sterol, one of the sterols found in hazelnuts, has the feature of preventing cholesterol synthesis and reducing its absorption in the intestine by absorbing cholesterol (Simsek and Aslantas, 1999). As a result of studies on public health in the USA, it has been observed that coronary heart diseases were reduced by 50% in people who consume nuts 4 times a day. In another study on the subject, it was determined that the blood sugar and blood pressure levels in diabetics who were on a hazelnut diet decreased due to the oleic acid which is present in hazelnuts and that the triglyceride and LDL cholesterol levels in the blood decreased while HDL cholesterol increased thereby decreasing total cholesterol levels (Simsek and Aslantas, 1999). The fatty acid composition of hazelnut oil contains up to 82% oleic acid. Oleic acid increases the rate of high-density lipoprotein (HDL) in human blood and reduces blood cholesterol, thus reducing the risk of cardiovascular diseases. It has been determined that people who eat hazelnuts at least once a day have decreased the possibility of contracting cardiovascular diseases by 50% compared to those who never eat hazelnuts (Yucesan et al. 2003). The composition of hazelnut oil is similar to that of olive oil. Studies have shown that hazelnut contains the most oleic fatty acids (80%), followed by linoleic, palmitic, stearic, and linolenic fatty acids, respectively (Amaral et al. 2003; Alasalvar et al. 2010). It was stated that the high amount of oleic acid provides resistance to fat and reduces cholesterol levels in diets. Recent scientific research has shown that oleic acid prevents the rise of cholesterol in the blood, regulates blood sugar, and has a protective effect against cardiovascular diseases (Bail et al. 2009). Oleic acid (C18:1), which is found in unsaturated fatty acids, has a cholesterol-lowering effect and is suitable for nutrition, as it is easily digested and easily broken down in the body. Besides, it has been scientifically proven to have many benefits for cardiovascular health. When compared with several almond varieties, the hazelnut oils were determined to have a low level of SFA (7.46-9.59%), intermediate level of PUFA (3.92-13.86%), and high level of MUFA (78.10-87.26%) (Mensink et al. 1993; Hu et al.1997). In various studies on the fatty acid composition of hazelnut, palmitic acid was found to be 4.9-8.3% and stearic acid was determined to be between 1.3-3.8%. In addition, the same

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study revealed that Negreta had the highest oil content at 69.03 g/100 g, while M. Bollwiller had the lowest oil content at 59.25 g/ 100 g (Parcerisa et al. 1995). Nuts are a rich source of phytosterols. Phytosterols, which are found in free form in nature, are found in an esterified form with phenolic acids or glycosides (Quilez et al. 2003). Sterols both reduce blood cholesterol and have the ability to change the anticancer and immune systems. Awad et al. (2001) and Plat and Mersink (2001), found in their study that hazelnuts taken as part of a diet increased the levels of HDL cholesterol and triglycerides while reducing the total cholesterol and LDL-cholesterol levels in the blood. HDL/LDL is an important criterion for atherosclerosis. Therefore, it has been observed that it increases significantly in people who consume hazelnuts.

## **Conclusion**

Research over the last 30 years has revealed that there is a relationship between people's eating habits, diseases, and healthy living. While investigating the relationships between nutrition and some well-known diseases, the most questioned food component/food item was fats. It has been demonstrated by scientific studies that pistachios play an important role in the healthy diet of individuals and in reducing the risk of nutrition-related diseases, thanks to the fiber, unsaturated fat, phenolic compounds, vitamins, and minerals in their content. Numerous studies have reported pistachio has positive effects on various chronic diseases such as diabetes, hypertension, and especially cardiovascular diseases. Regular consumption of pistachios helps protect human health and provide the daily recommended nutritional requirement. Pistachio, which has functional properties, is recommended to be consumed especially in certain foods to enhance flavor and improve visual presentation, as well as maintaining a healthy life. Walnuts have a high nutritional value and is defined as a functional food because their fruit, shell and leaves are used as a support for medical treatments. Essential fatty acids, which contribute greatly to the healthy functioning and development of the human brain, are abundant in walnuts. For a more balanced and healthy diet, walnut consumption should be given importance. In this regard, necessary awareness should be created about the fact that walnut fruit contains high levels of fatty acids and their benefits. Research on the benefits of omega-3 fatty acids, which are high in walnuts, on human health continues in different areas such as cancer, depression, Alzheimer's, and diabetes. Today, studies revealing the positive correlation between nutrition and health draw attention to the fact that the consumption of functional components in the daily diet can prevent diseases and improve the quality of life. Almonds, a nut which is among the functional foods, are recommended to be consumed in a certain amount every day as it has a positive effect on the prevention of the development of many acute and chronic diseases and in the treatment of some of them. Almonds, a fruit that can be grown in the geographical conditions of our country, are considered an agricultural product whose production should be increased due to its valuable nutritional and functional properties. Hence, it is important to give more importance to almond cultivation and production both in closed plantations and in field conditions and to encourage producers in this regard. Turkey has an important position in hazelnut production and export. In addition to its economic importance, the fat, protein, vitamin, and mineral substances are very important in terms of human nutrition and health. Therefore, it can be suggested that hazelnuts be taken directly every day for a balanced and healthy diet, or projects can be developed to increase hazelnut consumption by adding them to the compositions

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of various foods to be processed. For instance, the development of products enriched with natural foods that contain high nutritional value, which are popular today, can contribute to both increasing the amount of consumption and making the nutrient content of the developed products richer and healthier by including hazelnuts within the scope of the projects.

Nuts such as almonds, walnuts, hazelnuts, and pistachios are very important foods for human nutrition and health due to the fat and unsaturated fatty acids, protein, carbohydrates, vitamins, minerals, dietary fiber, and plant sterols they contain. Nuts contain vitamin E, which has antioxidant properties, and they influence lowering cholesterol and lipoprotein levels with their monounsaturated fatty acids and non-lipid components. Antioxidants and phytochemicals found in nuts have an inhibitory effect on the development of many chronic diseases such as diabetes by preventing the damage of free radicals to cells and increasing body resistance, and they are also in the group of nutrients that reduce the risk of cancer (Ozer and Guven, 2008). Nuts are extremely rich in terms of energy values and nutritional content. It is important to consume nuts in daily recommended amounts in order to maintain nutritional diversity and health. As it can be understood from the studies on the effects of fatty acids in nuts on human nutrition and health, it is thought that it would be appropriate to consume at least 1-2 times a week since it is an excellent food source due to the amino acids, fatty acids and healing effects in some diseases of our age.

### **Conflict of interest**

Authors have declared no conflict of interest.

### **Authors contributions**

The authors contributed equally.

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