

CHAPTER 1

INGREDIENTS AND HEALTH BENEFITS OF WALNUT

Prof. Dr. Ahmet KAZANKAYA ¹

Assist. Prof. Dr. Adnan DOĞAN ²

Assist. Prof. Dr. Haydar KURT ²

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¹ Kırşehir Ahi Evran Üniversitesi, Ziraat Fakültesi, Bahçe Bitkileri Bölümü, Van, Türkiye. akazankaya@hotmail.com

² Van Yüzüncü Yıl Üniversitesi, Ziraat Fakültesi, Bahçe Bitkileri Bölümü, Van, Türkiye. adnandogan@yyu.edu.tr - haydarkurt@yyu.edu.tr

INTRODUCTION

Walnut is a type of fruit that has been consumed globally for many years and it is also an important source of commercial income for many countries. The walnut, which belongs to the species *Juglans regia* L., is cultivated especially in regions such as Anatolia and Iran and has wide usage worldwide (Zhao et al., 2017; Demir et al., 2018). Turkey holds a significant position in walnut production and is a country with a deep-rooted tradition in horticulture. Its geographical location makes Turkey the homeland of many fruit species, making it a rich resource in terms of biodiversity (Ercişli et al., 2012). The world's walnut production is around 3.5 million tons. Turkey, which has an important position in walnut cultivation, ranks fourth in the world walnut production after China, the USA, and Iran. Turkey contributes 9.28% of the world's production with an annual output of 325,000 tons (Nadeem, 2021).

In recent years, there has been increasing interest in natural foods, and within this trend, fruits that are natural sources of antioxidants have come to the fore. Walnut is a food that stands out with its rich nutritional content and popularity. With the growing awareness of the importance of healthy eating and natural foods, plant-based foods, especially nuts like walnuts, are increasingly attracting attention due to their positive effects on human health (Qamar et al., 2020).

Nutritionists and researchers emphasize that walnuts are an important source for health. Walnuts contain nutrients such as protein, healthy fats, minerals, and vitamins. In particular, walnuts are a rich source of protein and contain many of the essential amino acids required by the body. Additionally, walnuts are rich in healthy fats, especially unsaturated fatty acids, which are beneficial for heart health. In terms of minerals, walnuts contain manganese, copper, magnesium, and phosphorus. Walnuts, which are also rich in vitamins, are an important source of vitamin E and B group vitamins. With the combination of these nutritional components, walnuts support a healthy nutritional regime when consumed regularly (Martínez et al., 2010).

Epidemiological and clinical studies indicate that regular walnut consumption can have various positive effects on health. These studies reveal the potential benefits of walnuts in the treatment and prevention of common health issues such as cancer, obesity, diabetes, cardiovascular diseases, and other chronic disorders. For example, the antioxidant properties associated with

walnut consumption can help inhibit the growth of cancer cells and reduce inflammation. Moreover, as a fiber-rich food, walnuts can assist in managing metabolic diseases like obesity and diabetes. Furthermore, the high antioxidant content of walnuts can prevent the development of cardiovascular diseases and support heart health. Therefore, these epidemiological and clinical studies demonstrate that regular walnut consumption can play a significant role in overall health (Berkey et al., 2012; Crovesy et al., 2021; Anwar et al., 2020; de Souza et al., 2017).

Walnut is a significant source in terms of antioxidant potential, and this feature is associated with antioxidant phenolic compounds. Antioxidant phenolic compounds fight free radicals by preventing cellular damage and can reduce the effects of oxidative stress. These compounds can prevent the development of various diseases and provide positive effects on overall health. Additionally, the richness of walnuts in organic acids enhances their antioxidant properties and encourages their use for pharmacological purposes. The antioxidant properties of organic acids can be effective in reducing cellular oxidative stress and can play a protective role in health. Moreover, the high content of unsaturated fatty acids in walnuts, particularly oleic acid, linoleic acid, and linolenic acid, is also considered an important source in terms of nutrition. These fatty acids can support cardiovascular health, improve blood lipid profiles, and reduce inflammation. Thus, the antioxidant and fatty acid content of walnuts can provide positive effects on health in various ways (Cosmulescu et al., 2015; Ürün et al., 2021).

Walnut attracts attention with its long history of use not only in nutrition, but also in traditional folk medicine and in the cosmetic and pharmaceutical industries. The reasons behind the use of walnuts in these areas are the health effects of the various compounds it contains. These compounds can generally be divided into various subcategories such as phenolic acids, saponins, quinones, alkaloids, flavonoids, butyl phenyl ether, coumarin, tannic acid and polysaccharides. Phenolic acids have antioxidant properties and can reduce cellular damage. Saponins may exhibit anti-inflammatory and anti-carcinogenic properties. Quinones may have antimicrobial activity, while alkaloids may have a variety of pharmacological effects. Flavonoids may have antioxidant and anti-inflammatory properties. Butyl phenyl ether may exhibit antioxidant and antimicrobial activity. Coumarin may prevent blood clotting

and have antioxidant effects. Tannic acid may have anti-inflammatory and antiviral properties, while polysaccharides may support the immune system. The fact that these compounds have various pharmacological and cosmetic effects has supported the use of walnuts in traditional medicine and cosmetic products (Cardoso et al., 2012; Caldas et al., 2012).

Walnut is a fruit with significant importance in human nutrition and provides numerous health benefits. Research indicates that walnuts can play a potential protective role in the treatment and prevention of various diseases. Therefore, the nutritional importance and health benefits of walnuts require increasing research and attention.

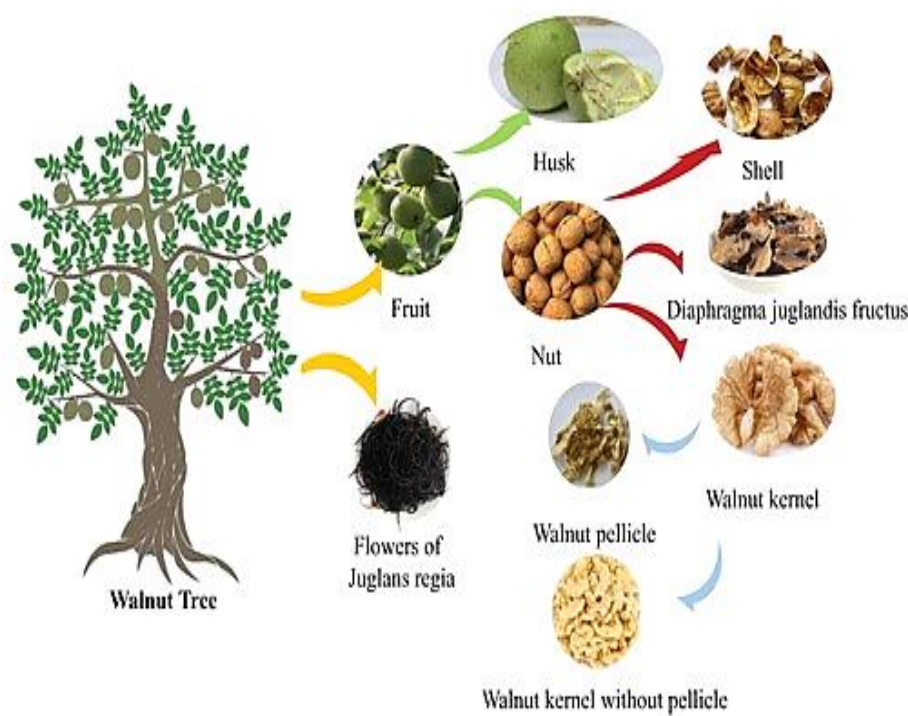


Figure 1. Schematic representation of different parts of the walnut (Ni et al., 2022)

SCIENTIFIC STUDIES ON DIFFERENT COMPONENTS OF THE WALNUT TREE

Recent research has revealed that walnuts play a significant role in human health and nutrition. It is indicated that this fruit is beneficial in the treatment of various diseases such as cardiovascular diseases, certain types of

cancer, nervous system health, diabetes, and obesity (Guasch-Ferre et al., 2013; Hardman, 2014; Sánchez-González et al., 2016; Poulouse et al., 2014; Pribis, 2016; Cole & Florez, 2020; Njike et al., 2015; Zileli et al., 2016).

Studies show that the antioxidant potential of walnuts is significant and that they are a rich source of phenolic compounds (Cosmulescu et al., 2015). Furthermore, the organic acids found in walnuts are noted for their antioxidant properties, making them widely used for pharmacological purposes (Ürün et al., 2021).

Walnuts typically contain high amounts of unsaturated fatty acids. Particularly rich in oleic, linoleic, and linolenic acids, walnut oil is found to have the highest levels of total polyunsaturated fatty acids and linoleic acid among nuts (Arcan et al., 2021; Okatan et al., 2022; Jahanban-Esfahlan et al., 2019; Kafkas et al., 2020).

Walnuts have been widely used not only as a healthy food but also in traditional folk medicine, and the cosmetics and pharmaceutical industries (Cardoso et al., 2012). The compounds found in walnuts are generally categorized into various subcategories such as phenolic acids, saponins, quinones, alkaloids, flavonoids, butyl phenyl ether, coumarin, tannic acid, and polysaccharides (Caldas et al., 2012).

Phenolic compounds are considered the main antioxidants in walnuts and are associated with anti-carcinogenic, anti-inflammatory, antibacterial, anti-aging, anti-fungal, neuroprotective, and other functions. It has been suggested that treatment with phenolic compounds can improve the endogenous antioxidant system to prevent skin aging (Rahmani et al., 2018).

Walnuts also contain omega-3 fatty acids, particularly alpha-linolenic acid (ALA), and about 6-7% dietary fiber. Moreover, it is noted that walnut consumption can cause changes in the gut microbiome, and different bacterial communities have been linked to many chronic diseases such as cancer, heart disease, and brain health (Emili et al., 2020). Nakanishi and colleagues (2016) have shown that a diet containing walnuts can help prevent colon cancer, and this effect is associated with changes in the gut microbiome.

Walnuts have been an important food item in human nutrition for many years and are recognized as an important plant worldwide due to their rich phytochemical content (Gandev, 2007). The high protein and fat content of walnuts make them indispensable for human nutrition. Additionally, walnuts

are rich in protein, vitamins, fats, and minerals and are considered an effective source of phytochemicals such as polyphenols, phenolic acids, and flavonoids (AbuTaha and Wadaan, 2011).

Nutritional value and content are influenced by genotypes, varieties, ecological factors, and soil properties. Research shows that the fats in walnut kernels range from 45-68% and proteins from 13-16% (Martinez et al., 2010; Muradoğlu et al., 2010; Gupta et al., 2019). Therefore, walnuts have played an important role in the functional food market for a long time.

Walnuts are of great scientific interest due to their many health benefits. Various studies have highlighted the physiological importance of the nutrients (such as polyphenols and vitamins) found in the leaves, flowers, shells, and kernels of walnuts (Ni et al., 2021). These studies have focused on the potential protective role of walnut consumption against various diseases such as cancer, intestinal dysbiosis, cardiovascular, and neurological diseases.

The therapeutic effects of a walnut-enriched diet on chronic diseases are particularly associated with its antioxidative and anti-inflammatory activities. Therefore, the synergistic or individual effects of walnut components may play a protective role against various health problems (Ni et al., 2021). As noted by Ni and colleagues (2021), the lipid profile of walnuts is of great interest due to its broad range of biological advantages and functions, contributing to overall health.

Walnut Kernel and Health Effects

The walnut kernel is a significant component of the walnut fruit, making up about half of the fruit's total weight. This content is rich in protein, lipids, and minerals, making it an excellent energy source. Additionally, it stands out for its high B-6 vitamin content and contains significant amounts of B group vitamins. These components are critical for brain health as they enhance memory and support longevity. Furthermore, they help protect heart health and prevent bone loss (Sharma et al., 2022).

Antidiabetic and Hepatoprotective Activities

Aqueous extracts obtained from the walnut fruit have been found to be effective against gram-positive and gram-negative bacterial strains (Poyrazolu and Biyik, 2010; Deshpande et al., 2011). The use of natural antimicrobial compounds in food preservatives is preferred to avoid the potential side effects

of chemical preservatives and to reduce antibiotic resistance. Therefore, extracts from various parts of the walnut plant and preparations containing juglone are used in the pharmaceutical field against microbial infections (Khattak et al., 2022).

In a study on the antidiabetic activity of walnuts, it was found that walnuts have a rich polyphenol content that shows strong inhibition against different enzymes such as amylase, maltase, sucrase, and glucosidase. Polyphenolic compounds such as Tellimagradin I, Tellimagradin II, and Casuarictin have also been reported to exhibit antidiabetic activity. These compounds have been observed to have a reducing effect on triglycerides and urinary peroxidase in cases where Type II diabetes is genetically inherited. These findings suggest that walnuts could be used as a potential treatment or preventive agent against metabolic disorders related to diabetes (Fukuda et al., 2004; Jelodar et al., 2007; Jafari et al., 2013).

In a study conducted to observe the protective effect of walnuts on liver health, the hepatoprotective activity was emphasized. It was reported that oral administration of walnut polyphenols showed a protective effect against liver damage in a model of CCL4-induced liver injury in mice. This finding suggests that walnut polyphenols may be a more effective hepatoprotective agent than the commonly used compound curcumin. The essential phytochemicals found in various parts of the walnut were identified as polyphenolic components, which are responsible for oxidative stress-induced liver damage. One of these polyphenolic components, Tellimagrandins I, has been identified as key components of hepatoprotective activity (Hiroshi et al., 2008; Christopoulos and Tsantili, 2011; Choudhary et al., 2020).

Anticancer and Antioxidant Effects

Various researchers have conducted studies on the anticancer activity of walnuts and walnut components such as juglone. Juglone functions as a promising chemopreventive agent against many cancerous cells. It has been reported to have strong cytotoxic effects on human tumor cells, induce apoptosis, and inhibit the growth of sarcoma cells. Additionally, walnut leaves, tree bark, green husk, and other walnut components exhibit significant anticancer properties through mechanisms such as growth inhibition, antiproliferative effects, activation of the mitochondrial death pathway, and the

formation of reactive oxygen species (ROS). The molecular foundations of juglone's effects on cell cycle arrest and apoptosis in human endometrial cancer cells have been investigated. Juglone was observed to affect the mitochondrial pathway by increasing ROS levels, thereby triggering apoptosis and preventing the migration of cancer cells. By inducing programmed cell death in endometrial cancer cells, juglone is proposed as a therapeutic strategy for the treatment and prevention of endometrial cancer. These findings suggest that juglone could be a potent natural anticancer agent and warrant further investigation through in vitro studies (Avanzato, 2010; Ji et al., 2011; Bennacer and Cherif, 2016; Al-Snafi, 2018; Arya et al., 2020; Zhang et al., 2019, 2021).

Antioxidant Properties and Effects on the Immune System

Walnut extracts obtained from various parts of the walnut tree have shown antioxidant capacity through free radical scavenging methods and have reduced lipid oxidation (Carvalho et al., 2010; Abbasi et al., 2010; Qamar and Sultana, 2011). This antioxidant activity has been observed against DPPH, H_2O_2 , and superoxide anion radicals. Walnuts are known as a food that supports heart health due to their phytochemicals, lipid-soluble bioactives, and other antioxidants. Because of these properties, walnuts are considered an ideal choice for snacks and dietary supplements. Moreover, consuming walnuts is suggested to improve cognitive function by reducing oxidative stress and enhancing antioxidant defense, thereby potentially reducing the risk of various diseases (Ni et al., 2021; Sharma et al., 2022).

Research has reported that walnuts enhance memory and learning abilities, acting as a memory enhancer by increasing serotonin levels in the brain and improving memory and learning capacity (Asadi-Shekaari et al., 2013). Another study indicated that polyphenol extracts from green husks and walnut kernels remarkably enhanced learning and memory function in the brain (Shi, 2014).

Walnut fruits have been reported to enhance and strengthen the immune system by increasing phagocytosis in various macrophages and enhancing lymphocyte proliferation (Delaviz et al., 2017; Danh et al., 2020).

Leaves and Health Effects

Walnut green leaves are used in the treatment of various health issues. Particularly, they are known to be effective in treating skin disorders, eye

irritations, eye pain, and conjunctivitis. They are also used to alleviate appetite loss. An infusion made from the leaves is used for eye wash to alleviate irritations and treat conjunctivitis, and the same tea is known to help heal wounds, acne, and skin allergies (Sharma et al., 2022). It has been found that walnut leaf extract contains antiviral compounds, and Juglone exhibits antiviral properties due to its protein-ligand binding affinity against viruses using virtual docking In Silico methods (Akram et al., 2013; Rosaria et al., 2019).

Furthermore, research has examined the antifungal activities of extracts obtained from walnut leaves. Bioactive compounds such as juglone and eugenol were isolated from leaf extracts using column chromatography. These compounds have been reported to exhibit antifungal properties against various fungal pathogens (Fang et al., 2015; Sharma et al., 2022)

The antifungal activity of walnut leaves against *Candida albicans* pathogenic isolates was evaluated using different extracts, with methanolic extract showing the maximum antifungal activity (Oliveira et al., 2008). Walnut leaf, bark, fruit, and green husk aqueous extracts have been found effective against both gram-positive and gram-negative bacterial strains (Poyrazolu and Biyik, 2010; Deshpande et al., 2011). Additionally, extracts from walnut leaves have shown microbicidal activity against microorganisms; for instance, leaf extract has been found effective against bacteria causing acne on the skin (Qadan et al., 2005; Sharma et al., 2022).

Walnut Shell and Health Effects

Walnut shell powder is one of the key components used in beauty products for treating sunburn and sunburn-related issues (Sharma et al., 2022). Various types of extracts such as methanolic, chloroform, acetone, and ethyl acetate extracts obtained from walnut shells have exhibited antifungal properties against different fungal species including *Candida*, *Fusarium solani*, *Alternaria alternata*, and *Aspergillus niger* infections (Fang et al., 2015; Mohammed et al., 2018). Aqueous extracts derived from walnut green husks have been found effective against both gram-positive and gram-negative bacterial strains (Poyrazolu and Biyik, 2010; Deshpande et al., 2011). Extracts from walnut shells have also demonstrated microbicidal activity against microorganisms (Qadan et al., 2005).

A study highlighted significant activity of acetone extract from walnut shells against *Eicinia feotida* organisms. Moreover, ethanol, methanol, and benzene extracts from the shells have been reported to exhibit significant anthelmintic (worm-killing) activity against *Pheretima posthuma* organisms. Researchers have noted that this anthelmintic activity is maximum in the shell's body (Upadhyay et al., 2010; Sharma et al., 2022).

Walnut inner shell membrane of walnut and health effects

The inner shell of walnut can be used to make both decoctions and tinctures. Decoction can be employed to treat constipation and aid weak digestion, stimulate the liver, and even treat skin disorders (Sharma et al., 2022). Aqueous extracts obtained from the fruit shell have been found effective against both gram-positive and gram-negative bacterial strains (Poyrazolu and Biyik, 2010; Deshpande et al., 2011).

Research on the potential effects of extracts from walnut shells on helminth infections found that acetone extract from walnut shells showed significant activity against *Eicinia feotida*. In addition, ethanol, methanol, and benzene extracts from the shell were reported to exhibit significant anthelmintic (worm-killing) activity against *Pheretima posthumana*. Researchers noted that this anthelmintic activity was maximum in the shell's bark (Upadhyay et al., 2010).

CLASSIFICATION OF WALNUT COMPOUNDS

Studies have shown that edible walnuts can provide various health benefits, primarily due to phytochemicals such as phenolic compounds. Flavonoids derived from phenolic substances, phenolic acids, tannins, and naphthoquinones fall into the category of plant polyphenols, ranking second only to cellulose, hemicellulose, and lignin in plants (Şen et al., 2006). These compounds regulate plant growth and development, contribute to metabolic reactions, and can have positive effects on health. Particularly, walnut polyphenols are one of the biologically active components of walnuts and offer beneficial health effects. Flavonoids can form glycosides and aglycones in plants, while phenolic acids belong to the class of organic acids, with gallic acid being one of the most common components (Beiki et al., 2018).

Tannins are divided into two main groups: hydrolyzable tannins and ellagitannins, which include gallotannins. Ellagitannins contain gallic acid and

hexahydroxydiphenic acid (HHDP) and are generally more stable compared to gallotannins. Quinones are molecules typically characterized by unsaturated structures and hold particular importance in traditional Chinese medicine (Beiki et al., 2018; Nieto et al., 2020).

Walnuts have been a significant food source in human nutrition for many years. They are recognized globally as an important plant due to their rich phytochemical content (Gandev, 2007). Different components have been observed to serve different functions, and these components may vary in their proportions in different parts of the walnut. For example, while walnut husks significantly contribute to the tannin content of walnuts, the inner kernel is rich not only in tannins but also in high protein and fat content, making walnuts indispensable in human nutrition. Walnuts are a rich source of protein, vitamins, fats, minerals, and effective phytochemicals (Table 1) (Şen et al., 2006; AbuTaha and Wadaan, 2011; Alasalvar and Shahidi, 2020; Sharma et al., 2022).

Walnut is a significant food source in daily nutrition, providing various nutrients (Table 1). Considering a daily energy requirement of approximately 8400 kJ, consuming 100 grams of walnuts meets about 32% of this need. Similarly, while the recommended daily fat intake ranges between 20-35%, consuming 100 grams of walnuts covers 50% of this requirement. Rich in protein as well, walnuts provide about 30% of the daily protein requirement (Şen & Karadeniz, 2015).

Walnuts are also rich in minerals such as iron and zinc. For instance, consuming 100 grams of walnuts fulfills 32% of the daily iron requirement and 28% of the zinc requirement. Being rich in omega-3 fatty acids, walnuts can contribute significantly to weekly omega-3 intake. Among the vitamins found in nutrient-rich walnuts, vitamin A provides 2.3% of the daily requirement, vitamin E offers 139.2%, and vitamin K provides 207%. Additionally, B vitamins including folate, niacin, pantothenic acid, pyridoxine, riboflavin, and thiamine in walnuts contribute to a significant portion of the daily requirement (Şen & Karadeniz, 2015).

Table1. The chemical structure of walnut

Component	Amount (per 100 grams)	Percentage (%)
Energy	2,738 kJ (654 kcal)	-
Carbohydrates	13.71 g	-
- Starch	0.06 g	-
- Sugars	2.61 g	-
- Lactose	0 g	-
- Dietary Fiber	6.7 g	-
Total Fat	65.21 g	-
- Saturated Fat	6.126 g	-
- Monounsaturated Fat	8.933 g	-
- Polyunsaturated Fat	47.174 g	-
Protein	15.23 g	-
Vitamins	Amount	Percentage (%)
Vitamin A equivalent	1 µg	0%
Beta-carotene	12 µg	0%
Lutein + Zeaxanthin	9 µg	0%
Vitamin A	20 IU	-
Thiamine (B1)	0.341 mg	30%
Riboflavin (B2)	0.15 mg	13%
Niacin (B3)	1.125 mg	8%
Pantothenic Acid (B5)	0.570 mg	11%
Vitamin B6	0.537 mg	41%
Folate (B9)	98 µg	25%
Vitamin B12	0 µg	0%
Vitamin C	1.3 mg	2%
Vitamin D	0 µg	0%
Vitamin E	0.7 mg	5%
Vitamin K	2.7 µg	3%

Trace Minerals	Amount	Percentage (%)
Calcium	98 mg	10%
Iron	2.91 mg	22%
Magnesium	158 mg	45%
Manganese	3.414 mg	163%
Phosphorus	346 mg	49%
Potassium	441 mg	9%
Sodium	2 mg	0%
Zinc	3.09 mg	33%
Water	4.07 g	

http://www.nal.usda.gov/fnic/cgi-bin/nut_search.pl; Şen et al., 2006; Şen & Karadeniz (2015) Sharma et al., 2022.

Considering a daily energy requirement of approximately 8,400 kJ, consuming 100 grams of walnuts meets about 32% of this need, as walnuts contain 2,738 kJ (654 kcal) per 100 grams. Additionally, while the recommended daily fat intake ranges between 20-35%, consuming 100 grams of walnuts covers about 50% of this requirement, as they contain a total fat of 65.21 grams, which includes 6.126 grams of saturated fat, 8.933 grams of monounsaturated fat, and 47.174 grams of polyunsaturated fat.

Walnuts are also rich in protein, providing approximately 30% of the daily protein requirement with 15.23 grams of protein per 100 grams. They are abundant in minerals such as iron and zinc; specifically, consuming 100 grams of walnuts fulfills about 32% of the daily iron requirement (2.91 mg, which provides 22% of the daily value) and approximately 28% of the zinc requirement (3.09 mg, which fulfills 33% of the daily value).

Moreover, walnuts are rich in omega-3 fatty acids, significantly contributing to weekly omega-3 intake. Among the vitamins found in nutrient-rich walnuts, vitamin A provides about 0% of the daily requirement (1 µg), vitamin E offers 5% (0.7 mg), and vitamin K provides about 3% (2.7 µg). Additionally, B vitamins including thiamine (B1) at 30% (0.341 mg), riboflavin (B2) at 13% (0.15 mg), niacin (B3) at 8% (1.125 mg), pantothenic acid (B5) at 11% (0.570 mg), vitamin B6 at 41% (0.537 mg), and folate (B9) at 25% (98 µg) contribute significantly to daily nutritional needs.

WALNUT AS A FUNCTIONAL FOOD AND ANATOLIAN CULTURE

Functional foods are foods that go beyond basic nutrients and provide specific health benefits. These foods contain special components that can support body functions or prevent certain health problems. Functional foods are generally rich in nutrients such as vitamins, minerals, antioxidants, probiotics, prebiotics, and fatty acids, which have positive effects on human health (Alaşalvar and Pelvan, 2009).

Approximately 2500 years ago, the famous saying of the medical pioneer Hippocrates, "Let food be thy medicine and medicine be thy food," still holds importance today. Among functional foods recognized for their positive health effects, antioxidants are one of the most common. Antioxidants are derived from natural sources such as phenolic compounds and are frequently used in

functional food products. Research reports indicate that these compounds can lower cholesterol levels in the blood, provide protective effects against osteoporosis and cancer, and may also be effective in preventing unwanted bacterial infections. Therefore, antioxidants are highly valuable components for health (Şen et al., 2006; Tekeli et al., 2008).

Walnuts hold a significant place in Turkish cuisine and are used in many dishes. This usage plays a critical role in shaping traditional Turkish flavors and becoming part of our cultural heritage. Walnut kernels are considered a key ingredient in various Turkish dishes and sweets (Şen, 2005).

In Turkish cuisine, walnuts are used across a wide range of dishes, from salads to pastries, cakes to desserts. Particularly in salads, walnuts are known to enhance both flavor and nutritional value. Walnut-filled pastries and cakes are among the indispensable flavors of Turkish cuisine. Walnuts are also commonly used in Turkish desserts, especially in traditional sweets like baklava, adding both flavor and nutritional value. In addition to meals, walnuts are frequently used in snacks. Consuming walnut kernels either salted or sweetened by removing the shell is quite popular (Şen et al., 2006).

Baklava, especially varieties made with walnut kernels, is one of the most beloved Turkish desserts. Besides baklava, walnuts are essential in sweets such as köme (a type of fruit roll), pestil (fruit leather), walnut jam (walnut pekmez), walnut lokum (Turkish delight), and nuska (walnut-based confection). Walnuts in Turkish cuisine extend beyond desserts. For instance, "bastık," a type of pestil from Kahramanmaraş region filled with walnuts, holds significant culinary importance. Moreover, in some villages of Central Anatolia, "batırak," a dish made with moistened bulgur and walnuts, serves as a substantial component. Villagers rely on traditional knowledge, noting that combining walnuts with bulgur complements protein deficiency, making it an excellent food source. Therefore, walnuts play a crucial role as an important ingredient in traditional recipes like raw köfte (Çiğ köfte) in certain regions (Şen et al., 2006).

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