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Derleme / Review

Nutritional Composition and Health Benefits of Walnut and its Products

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ABSTRACT: Our food contains macro and micro components that are necessary for us to maintain our lives. In particular, it is mandatory to get the necessary vitamins and minerals for vital functions. Turkey has an enormous diversity of food products due to both geographical and climatic conditions. One of these products is walnut that is grown in almost all regions of our Turkey. Vitamin, mineral and fatty acid composition of walnut varies depending on climate conditions such as temperature and humidity. From the health perspective, walnut is considered a valuable food item. Due to its content of silver ions walnut has an important role in balancing brain health and cholesterol levels. On the other hand, walnut is rich in essential fatty acids such as omega-3 fatty acids. Walnut jam -as one of the walnut products is not common due to the high cost. However, the vitamins and minerals content of the walnut green shell – which is used in walnut jam production-, increased the demand and preference of walnut jam. Walnut and its products play an important role in prevention of cardiovascular diseases, cancer and diabetes because of its high content of unsaturated fatty acids. The outlines of this review are walnut functions and composition, its effect on human health, consumption amount and analysis methods, production of walnut products and its health effects.

Keywords: Walnut, Walnut jam, Composition, Traditional foods, Consumer health

Ceviz ve Ceviz Ürünlerinin Besinsel Bileşimi ve Sağlık Üzerine Etkileri

ÖZ: Gıdalarımız geçmişten günümüze hayatımızı sürdürebilmemiz için gerekli olan makro ve mikro bileşenleri içermektedir. Özellikle hayati fonksiyonlar için gerekli olan vitamin ve minerallerin alınması zorunludur. Ülkemiz gerek coğrafi koşulları gerekse de iklim koşullarından dolayı muazzam bir gıda çeşitliliğine sahiptir. Bu ürünlerden bir tanesi de cevizdir. Ülkemizin neredeyse bütün coğrafyasında yetişen ceviz iklim koşuluna (sıcaklık, nem) bağlı olarak vitamin, mineral ve yağ asidi kompozisyonu bakımından farklılık göstermektedir. Ceviz içermiş olduğu besin bileşimi bakımından çok önemli bir yer teşkil etmektedir. Özellikle içerdiği gümüş iyonları nedeniyle beyin sağlığı ve kolestrolün dengelenmesinde önemli bir yere sahiptir. Öte yandan içermiş olduğu elzem yağ asitleri bakımından zengin olan ceviz omega-3 yağ asidini de önemli oranda içermektedir. Ceviz ürünleri içerisinde yer alan ceviz reçeli günümüzde maliyetinin yüksek olmasından dolayı yaygın olmamasına rağmen üretiminde kullanılan yeşil kabuklu cevizin sahip olduğu vitamin ve mineralden dolayı ürünün tercih edilme ve talebini de artırmaktadır. Özellikle doymamış yağ asidi bakımından zengin olan ceviz ve ceviz ürünleri başta kardiyovasküler hastalıklar, kanser, diyabet gibi hastalıkların önlenmesinde ve beslenmede önemli bir yere sahiptir. Cevizin fonksiyonları ve bileşimi, insan sağlığı üzerine etkileri, tüketim miktarları ve analiz yöntemleri, ceviz ürünlerinin üretim şekli ve sağlık üzerine etkileri bu derlemenin konusunu oluşturmuştur.

Anahtar Kelimeler: Ceviz, Ceviz reçeli, Bileşim, Geleneksel ürünler, Tüketici sağlığı

INTRODUCTION

The walnut tree, which belongs to the family Juglandaceae, has been reported to have 18 different species and are found in Mediterranean, East Asia, India, USA, Canada, Central America and Andes regions. The Romans used to call it 'Jovis Glans' which means 'Jupiter's King Fruit', the source from which the genus name of the walnut became to be Juglans (Megep, 2009). Among the 18 species, the Anatolian walnut (*Juglandaceae* regia L, also known as Iranian walnut or English walnut), is the most grown and commercially important variety because

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of its size, sweetness, thin crust and easy break shells (Davis, 1982; Rosengarten, 1984; Akça, 2001).

Usually, the walnut is used in various products in order to improve taste, aroma and appearance, and to increase crispiness of the products. It is also used in combination with other hard-shell fruits, sugars, honey and syrup to make various pastes. In addition, walnuts are used in various traditional products such as walnut paste, walnut dried pulp (Pestil), preserve/dessert, walnut sugar, walnut sauce etc (Şen, 1986; Anonymous., 1991; Torun, 1999; Bakkalbaşı et al., 2010). Walnut, which has a wide range usability, and thanks to its health benefits, it occupies an important place in human diet in some parts of the world (Ruggeri et. al., 1998; Bakkalbaşı et. al., 2010).

Composition of Walnuts

The proximate composition of walnut has been reported to be as, 13.6-22.3% protein, 56.4-70.6% fat and around 2% ash. Importantly high biological value (low lysine / arginine ratio) and easily digestible protein makes it an important food in vegetarian diet (Sahin and Akbaş, 2001). Furthermore, in vegetarian diet, it is stated that most of the required amino acids could be supplied when walnut is consumed together with legumes (Şimşek and Gülsoy, 2016; Reiter et al.,2005; Serrano et al.,2005). Addition to essential amino acids, presence of essential fatty acids in walnuts are the components which makes them functional foods too. In particular, the fact that the oil is proportionally rich in polyunsaturated fatty acids increases its importance in nutrition. The walnut fat is composed of 72% polyunsaturated fatty acid (59% linoleic [n-6], 13% α-linolenic [n-3]), 18% monounsaturated fatty acids (oleic acid) and 10% saturated fatty acids. It is also found to contain significant amount of fat, fat soluble vitamins: vitamins A and vitamin E, water soluble vitamins: Vitamin B1, B2, folic acid, pantothenic acid and niacin, vitamin C and minerals (Lavedrine et al, 1999). Walnut is also a good source of manganese and copper which are essential minerals in important enzymes having the antioxidant activities (Şimşek and Gülsoy, 2016). Furthermore, the fiber present in walnuts also play an important role in digestive system (Serrano et al., 2005; Şimşek and Gülsoy, 2016).

Health Benefits of walnut and walnut products

Walnut is the only food source containing silver ions that are very beneficial for brain health, and the only organ that requires silver ion is the brain (Akça, 2001).

It has been reported that walnut exhibit more antioxidant activities compared to other hard-shell nuts (Pellegrini et al., 2006; Arcan and Yemenicioglu, 2009) and also a good source of essential fatty acids (Li et al., 2007). Therefore, it is frequently obvious that, in the epidemiological studies on the effects of both antioxidants and fatty acids on health, walnuts have been found to have protective effects on various diseases such as cardiovascular diseases, cancer and cataracts and aging (Lavedrine et al., 1999; Kaur and Kapoor, 2001; Arcan and Yemenicioglu, 2009).

In a study by Lavedrine et al. (1999) carried out in France, it was found that the polyunsaturated fatty acids contribute in reducing the risk of cardiovascular diseases and the principal source of polyunsaturated fatty acids being walnut and walnut oil.

In another study by Abbey et al., (1994), it was found that the walnuts which are rich in polyunsaturated fatty acids, reduces LDL cholesterol when taken as supplementary food (48 g day^{-1}). The walnut phenolics are the major components which have been found responsible with the antiatherogenic and antioxidant properties associated with the health benefits of walnut consumption (Anderson et al., 2001; Fukuda et al., 2003). Juglon, a phenolic compound and commonly found in walnuts, has been reported to have a potential to reduce melanoma tumor cells (Aithal et al., 2009).

Walnut contains polyunsaturated fatty acids (Omega 3 and Omega 6) in the ratio of 9.081g $100g^{-1}$ and 38.095g $100g^{-1}$ respectively (Simopoulous, 1999). Because of these fatty acids are not synthesized in human body, it must be supplied externally via foods. As walnuts are rich sources of these essential nutrients, it has become indispensable portion of the regular human diet (Heidal et al., 2004). According to FAO, together with low saturated fat and cholesterol diet, a daily intake of 42.5 g of walnut could prevent chronic heart diseases (Şimşek and Gülsoy, 2016). It has also been found that walnuts contain high amounts of δ- tocopherol (24-46 mg $100g^{-1}$) (Reiter et al., 2005).

The presence of oleic (18: 1 n-9), linoleic (18: 2 n-6) and linolenic (18: 3 n-3) acids in walnut oil is an important indicator for economic and nutritional value too. It should be noted that oils with low linoleic and linolenic acid content have a longer shelf life, whereas highly unsaturated (polyunsaturated) fatty acids are preferred for their health benefits. It is recommended that the walnut oil is not suitable for frying purposes because of its high linolenic acid content however, it can be used in bread, cake and biscuit production (Zwarts and Savage, 1999). L-arginine, one of the essential amino acids found in walnuts, has been reported to turn into nitric oxide in the human body, preventing arteriosclerosis (Şimşek and Gülsoy, 2016). On the other hand, the walnut oil is also used in the treatment of dry hair, dandruff and

head wounds. Walnut fruit's green peel and leaves have been reported to be used as a medicine for skin diseases, dental abscesses, herpes, intestinal worms, sweating of hands and feet, eczema and bee stings (Yiğit and Ay, 2016).

Walnut Products

Walnut preserve/dessert

Although grown almost in every region of Turkey, walnut specific to Adilcevaz, which is a district of Bitlis province, on the shore of Lake Van, has a special importance. The walnut jam which made by Adilcevaz's walnut is different from those made from other walnut types due to the fact that the walnut used has local characteristics. this species contains high levels of unsaturated fatty acids, able to grow at 2500 m altitudes, resistant to early spring frosts, self-pollinating species, fruiting starts 4 years after the plantation and able to adapt at any weather conditions. The high genetic quality of fruits grown in the Adilcevaz district is another feature that makes it valuable.

The Adilcevaz walnut which is different from other walnuts in terms of taste and quality, contains total 65% fat and is at the *first place/* first *secrets* among the walnut varieties. The weight of a whole fruit with shell is 18-25 g and the kernel (edible interior of the nut) to whole fruit ratio (edible part) is around 50-60%. The outer shell of the fruit is thin, the inner color (edible part) is white and easy to separate from the shell. The peel/bark of the fruit is smooth, the tree/plant has high fruit yield, and is resistant to diseases. Along with these features, Adilcevaz walnut is also a rich source of folic acid and vitamin E, iron, phosphorus, magnesium, potassium, zinc and omega 3 fatty acid. The nutritional composition of 100 g of walnut is given in Table 1 (Anonymous, 2017a).

The production of walnut jam is a very demanding process. Adilcevaz walnut jam; apart from consumption like classic jam, also consumed as dessert or served next to coffee as treat. Fresh, green shelled, immature nuts are used to make the jam. The fruits are/should be checked for their suitability to make jam in the month of June before the it begins to ripen (Anonymous, 2017a).

Table 1. Nutritional Value of 100 g of Walnut (Anonymous, 2017a; Anonymous, 2019c)

Nutritional Components	Amount in California Walnuts (average)	Amount in Adilcevaz Walnuts (average)
Carbohydrate (g)	13.71	6.9
Protein (g)	15.2	20.5
Fat (g)	65.21	70.8
Fiber (g)	6.7	6.7
Cholesterol (mg)	0	0
Sodium (mg)	2	2
Potassium (mg)	441	450
Calcium (mg)	98	99
Vitamin A (iu)	20	30
Vitamin C (mg)	1.7	2
Iron (mg)	2.91	3.1
Ash (g)	2.5	2.5
Water (g)	3.5	3.5
Phosphor (mg)	380	380
Magnzeyum (mg)	121	131
Thiamin (mg)	33	33
Riboflavin (mg)	9	13
Niacin (mg)	9	9
Energy Value (kcal)	654	700

Production of Walnut Preserve

First of all, walnuts that are not ripe and slightly larger than the hazelnuts are collected, and thin layer of peel is removed with a peeler. Peeled walnuts are placed in stainless steel containers, enough water is added to submerge it and left for 10 days until it becomes dark colored. The water is changed 4-5 times a day during the process (Figure. 1).



Figure 1. Walnuts soaked in water

At the end of the tenth day, the blackened walnuts are washed and placed in a container and enough 'lime water' is poured to cover it. After four hours, the lime settles to the bottom, a clear water layer on the top of the lime and a thin layer on the top of the water is formed. The topmost layer is discarded. The clear water layer and walnuts are carefully transferred to another container and kept for 5-6 hours, thoroughly washed and boiled (Figure 2). The boiled walnuts are then washed again 2-3 times, 3-4 small holes are poked with thin metal needles. It is then boiled in sugar syrup (1 6^{-1} sugar to water ratio). Cloves are added to the syrup which imparts flavor and aroma to the product.



Figure 2. Boiling of lime treated walnuts (Boiling of walnut preserve)

The completion of cooking (achieving suitable consistency) is determined by dropping a few drops of the preserve on cooled plate as: if the preserve does not flow easily on the surface of the plate after standing for a while, the cooking is said to be completed. After cooking to the suitable consistency, the hot preserve is placed in the jars and the lid of the jar is tightly closed. The jar is turned upside down and left for 1 day (Figure 3) (Anonymous, 2017b).



Figure 3. Walnut preserve

The aroma, taste and high nutrient content of Adilcevaz walnut makes the traditionally made Adilcevaz walnut preserve different from walnut preserves made in other regions (Anonymous, 2017b).

Walnut Paste

The most suitable walnuts to make paste is picked up in the months of August-September when the fruits are fully matured and the shell is hardened. The tough outer shell is removed, the interior (kernel) of the nut is then crushed in suitable container, some semolina is added intermittently along with addition of more walnut kernel. Water is added to the resulting paste. It is then cooked in a steel cauldron and cooled. Sugar is added and blended till it dissolves following by addition and continuous blending of more semolina and kernel paste thereafter, until final required texture is achieved. After the sugar added is dissolved and required texture is achieved, powder sugar is spread on a tray, then the prepared walnut paste is poured and spread on the tray. It is then cut into baklava like (rectangular cube) slices (Figure 4) (Anonymous, 2019a).



Figure 4. Walnut paste

Walnut oil

Walnut oil mainly consists of polyunsaturated fatty acids (72% of total fat), especially alpha-linolenic acid (14%) and linoleic acid (58%), oleic acid (13%) and saturated fats (9%) (Anonymous, 2019c). It could be used as cooking oil, but due to its high price, it is less preferred in food preparation than other oils. Even though, it is/could be used for deep frying, is avoided, because high temperature cooking reduces the taste of the oil and gives a slight bitterness to the fried products. Therefore, it is generally preferred to use as a cold/unheated ingredient such as salad dressing (Ben-Erik, 2014). Walnut oil can be extracted with the cold press process, but since this process is very expensive, it is generally produced in the factory (Anonymous, 2017b; 2019b).

CONCLUSION

Among the oil seeds, walnut, which contains high levels of unsaturated fatty acids (omega-3 and omega-6) and silver ions has an important role in brain health and nutrition of consumers. Moreover, it is also known to have more antioxidant effects than other hard-shelled fruits and therefore plays a protective role against various diseases such as cardiovascular diseases, cancer and aging. Walnut products are often recommended for breakfast because of their benefits to health, especially cardiovascular health. Due to its high unsaturated fatty acid content, walnut oil is more suitable to be used in cold appetizers and salads than high temperature cooking and frying. The consumption of walnuts and walnut products should be encouraged for a balanced and healthy diet. Increasing the scientific studies on the nutrients and health benefits of walnuts and walnut products will reveal unknown features of these products.

Statement of Conflict of Interest

The authors declare that there is no conflict of interests.

Authors' Contributions

HİB and EA cotributed to literature research and drafting of the article, İGŞ conceptualized the work and did critical revision of the article.

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