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Polyphenol content and antioxidant capacity of berries: A review

Muhammet Ali Gündeşli[1], Nazan Korkmaz[2], Volkan Okatan[3]*

[1]The Eastern Mediterranean Transitional Zone Agriculture Research of Institute, Kahramanmaras, Turkey
[2]Mugla Sitki Kocman University, Ortaca Vocational School, Ortaca, Mugla-Turkey
[3]Usak University, Faculty of Agriculture and Natural Sciences, Department of Horticulture, Uşak, Turkey

*Correspending author: maligun4646@gmail.com

Abstract

Nowadays in the world (especially in developed countries), increasing very important for human health, nutrition and protection from diseases has attracted consumer demand to foods and raw materials of high nutritional value. Berries, especially members of several families belonging to the best dietary sources of biochemical compounds. They have delicious taste and flavor, economic importance, and because of the antioxidant properties of some useful compounds, therefore, they are of great interest to researchers, nutritionists, and food technology experts. These compounds are responsible individually or in combination. For the various health benefits of berries in order to prevent the onset of chronic diseases and maintain health. In recent years, people's demand for healthy products has increased, in this way, many wild fruit species began to be cultivated in large areas. In particular, studies have focused on strawberries, currants, raspberries, blackberries, and blueberry due to their delicious taste and wide usage areas. These fruits contain high levels of phenolic compounds, anthocyanins, carotenoids, alkaloids, vitamins and have protective effects against health problems including degenerative diseases, cardiovascular diseases, diabetes, obesity and cancer and are recommended for a healthy diet. Such studies need to be developed extensively to detect and preserve important mulberry germplasm and to better understand the importance of such fruit species in the World. Berries, especially members of many families such as Rosaceae and Ericaceae are great dietary sources of biochemical compounds. these compounds (phenolic acids, flavonoids-flavonols, anthocyanins, tannins, and phenolic compounds such as ascorbic acid) are found in large amounts in berries and can function as potent antioxidants and therefore can help in the prevention and reduce of against many diseases including inflammation disorders, cardiovascular diseases, various cancers species. In summary, berries contain large amounts of phenolics and have also a high antioxidant activity and people use intensively in the last time for both healthy and their tastes.

Key words: *Berries, antioxidant, polyphenol, health, small fruit, review*

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Introduction

In the last few decades, there has been a constant increase of rich sources of biochemical compounds with health benefits popularity and interest regarding research of all fruit species. Berries have a special importance among other fruits due to their unique color, taste and odors, rich vitamin and mineral contents, and various usage possibilities in the food industry. It can grow even in the borders of many other fruit species. They are widely distributed in Asia and Europe to the North Pole, including the Caucasus and Iran in the south, all the Anatolian and Mediterranean countries and North African countries. Very rich species are found in the North American continent, especially in the USA and Canada. They are usually drawn to plateaus and high mountain ridges in cold climates. It was also shown that there were significant differences between berry species in Polyphenol content and antioxidant, which could be affected by ecologic factors, the degree of ripening and soil conditions.

Berries are commonly consumed in various products such as fruit juices, fruit juice concentrates, jams and marmalades in fresh or processed form or as a component of functional foods. In recent years, both wild and cultivated fruits have become very attractive to consumers due to the potentially useful phytochemicals found in these fruits. (Milivojevıc´ et al., 2011; Skrovankova et al., 2015).

These compounds are responsible for various health benefits of berries, such as the prevention of inflammation disorders, cardiovascular diseases or protective effects to lower the risk of various cancers (Karaağaç et al., 2019).

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Berries are rich in vitamins and minerals compared to other fruits. Berries contain significant densities compared to other fruits with their highly concentrated aromatic substances, various vitamins, and minerals. Berries are found as wild hedge plants in forest and field edges. Culture varieties of berries, after soft and hard seed fruits, stand out towards the end of the 16th century. Today, it is widely cultivated especially in Europe. It is widely used in marmalade, jam, fruit juice, and alcohol industry. Commonly-known berries are: strawberry (*Fragaria vesca* L.), currant (*Ribes* spp.), Blueberry (*Vaccinium* spp.), White mulberry (*Morus alba* L.) and black mulberry (*Morus nigra* L.), rosehip (*Rosa canina* L.), raspberry (*Rubus ideaus*) L.), blackberries (*Rubus fructicosus* L.), berberis (*Berberis vulgaris* L.) and gooseberry (*Ribes grossularia* L.).

Polyphenolic compounds are secondary metabolites of plants and constitute the largest group of phytochemicals that promote health. It is known that these compounds have important antioxidants, exhibit antiglycemic, antiviral, anticancer and anti-inflammatory activities and antiallergic and antimicrobial properties (Manach et al., 2004). The content of polyphenolic compounds is influenced by genotype, environment, soli conditions and agronomic applications.

For human health, vitamins E and C, carotenoids and phenolic substances are significant because of their antioxidant properties. Berries are also nutrient sources that contain high amounts of phenolic substances. The high antioxidant capacity of berries is due to phenolic substances, especially anthocyanins, rather than ascorbic acid (Tosun and Yüksek, 2003). Anthocyanins are responsible for the color of the fruit and the health-support properties. Cassidy et al. (2013) found that high anthocyanin intake in berries may reduce the risk of myocardial infarction between women. It was showed that the anthocyanin-rich extracts from some berries block growing of human colorectal cancer tumors (Cassidy et al., 2013). The most widespread anthocyanidins in berries are delphinidin, peonidin, cyanidin, pelargonidin, petunidin, and malvidin; they are present in combination with various sugar moieties, referred to as glycones, such as sophorose, rutinose, arabinose, rhamnose, xylose, galactose, and glucose (Miguel, 2011).

Berries are high-calorie nutrients due to their high sugar content. In addition, they are rich in calcium, potassium, sodium and iron, and are considered to be an important source of vitamins (vitamins A, B1, B2, niacin and C) (Karakaya and Kavas, 1999). Laboratory and clinical studies have shown that anthocyanins and phenolics, especially black raspberries, berries and blueberries, are effective in the treatment of tumors of different types of cancer (Xue et al., 2001; Gren et al., 2005; Stoner et al., 1999; Katsube et al., 2003; Kresty et al., 2001; Casto et al., 2002; Carlton et al., 2001). Nutrients of plant origin not only provide us with important antioxidant vitamins (Vitamins C, E, A), but also provide natural compounds with antioxidant properties. Recent studies have shown that antioxidant substances play an important role in the prevention of many degenerative diseases such as cataract, cancer, cardiovascular disorders and neurological disorders caused by oxidative stres (Schwartz, 1996; Halliwell, 1996; Mackerras, 1995).

This review will be aimed mainly to discuss the polyphenol content and antioxidant capacity of important berries species such as strawberries, currants, blueberry, mulberry, rosehip, red raspberry, blackberries, berberies and gooseberry.

Strawberry

Strawberry is a member of the genus *Fragaria* (family: *Rosaceae*). They are popular due to their desirable sweet taste and attractive aroma and among the fruits, fresh strawberries are considered to have the highest some polyphenolic compounds content. Strawberries as it contains essential nutrients and useful phytochemicals, it contributes to human health that because of their astringent and diuretic properties in many folk medicine and official pharmacopoeia sources such as skin diseases, LDL-cholesterol oxidation, cardiovascular incidents, inflammation of the nerves and lungs (Kafkas et al., 2006; Skrovankova et al., 2015). Strawberry phytochemicals are generally found in a wide range of phenolic compounds. These compounds content in strawberries in some cultivars are given in Table 1-2. Many studies have reported that strawberries have higher phytochemical compounds levels. Especially strawberry bioactive compounds (BAC) such as anthocyanins, flavones and other phenolic compounds are very important for the best human health. Strawberries are rich in phenolic content, especially ellagic, gallic, ferulic, catechin has been reported by many researchers (Table 2). In addition, higher levels of anthocyanins and antioxidant capacities were found (Table 1). But The total phenol and anthocyanin content of strawberries, compared to other common berries, is much lower than in blueberries and blackberries, and lower than in raspberries (Skrovankova et al., 2015; Wang et al., 2015). However, recent studies indicated that the contents of phytochemical compounds were highly dependent upon strawberries cultivar, while seasonal variations had a comparatively effect (Scalzo et al., 2013).

Currants

Currant is cultivated mainly for fruit juice production in European countries. It is also one of the plants that are used extensively in landscape areas. The juicy and delicious fruit of the currant is an important factor in the use of the food industry. In addition, buds, leaves, and stem parts are good sources of antioxidants and phenolic substances. Recently, blackcurrant teas have become very popular among health products. Especially the leaves and branches of black currants are powdered and used as raw materials for food, health, and cosmetic products. Since the scent of the leaves and buds of the currant is reminiscent of the smell of fruits, the powder form of these parts is used as an aroma.

The fact that the health benefits of red currant is increasing day by day increases the scientific studies and production even more (Brennan, 2008). Currant buds are rich sources of aroma volatile compounds, mainly the majority of which are hydrocarbons and oxygen moieties of organic compounds (Dvaranauskaite et al., 2009). The buds accumulate essential oil which has a pleasant aroma. This allows some harmful insects to come to the flowers and damage (Le Quere and Latrasse, 1990; Píry et al., 1995). Essential oils are isolated from sleeping buds and used in the cosmetics and perfume industry (Píry et al., 1995; Castillo del Ruiz and Dobson, 2002). In a study on buds, total phenolic and antioxidant content of buds were determined intensively (Tabart et al., 2011; Dvaranauskaite et al., 2009). Vagiri (2012) in a study on black currant buds sleeping buds were analyzed in different months by taking the highest total amount of phenolic buds were obtained in March. Table 1-2 shows some biochemical compounds of the ccurrant species. The antioxidant and anthocyanin capacity of currants, different to other berries, is correlated with various biochemical compounds that have antioxidant properties (Table 1-2).

Blueberry

The blueberry belongs to the family *Ericaceae*, subfamily *Vaccinoideae*, genus *Vaccinium*. Blueberries apart from being delicious have many human health benefits. Blueberry is a rich plant species phenolic, vitamin C, phenolic compounds and especially anthocyanin. Blueberries are known as “longevity fruit” fruit because of their high antioxidant capacity against free radicals and reactive species, and are considered one of the largest sources of antioxidants among all fruits and vegetables. They are highly elevated in antioxidants and are claimed to have anti-inflammatory properties and lower cholesterol in the blood, as well as improve motor skills, balance and coordination in the elderly (Wang et al., 2016). Therefore, in recent years, interest in blueberries with a positive impact on health has been increasing. Among the fruits, blueberries (*vaccinium* sp.), represented by various species and varieties, stand out and some exhibit significantly greater antioxidant activity than others (Moyer et al., 2002; Rodrıgues et al., 2011). The total contents of the phenolics include free phenolics, ascorbic acid (vitamin C), antioxidant and anthocyanin activity were given in Table 1-2. There are many publications in blueberry that have been reported to high biochemical and biochemical activities and high rate of antioxidant activity (Table 1-2). It is well documented that blueberries are rich in phenolics, particularly such as ellagic, gallic, ferulic, catechin chlorogenic and quercetin. Recent studies indicated that the contents of antioxidant and anthocyanins activity, catechin and quercetin were highly dependent upon blueberry (Cieslik et al., 2006; Karaağaç et al., 2019). It is also the main catechin and quercetin in blueberries, previously reported by Correa-Betanzo et al., 2014, Catechin is another important phytochemical of flavonoids found in fruits. Blueberry are known as a significant source of vitamins and among the richest fruits in ascorbic acid. The content is usually in quite wide intervals, between 4,54–100 mg/100 g. (De Souza et al., 2014; Skrovankova et al., 2015)

Mulberry

Mulberry (*Morus* spp.) is involved in the genus Morus, the tribe *Moracea* tribe, and the family *Moraceae*. They carry colorful berries most commonly black, white, or red. Nowadays, due to its nutritive value, mulberry is consumed in both fresh and processed forms. Mulberry fruit, can be used in different consumption ways such as syrup, jam, pulp, ice cream, vinegar, concentrated, alcohol. In addition, mulberry leaves and other plant organs are used pharmacologically throughout the World, especially Asia and North America (Ozgen et al., 2009; Gundogdu et al., 2011; Okatan, 2018). Mulberry is gaining worldwide popularity due to its sweet flavors, impressive nutritional values and various health benefits. In recent studies, mulberries are rich in many vitamins and minerals, particularly vitamin C and rich in plant compounds, such as phenolics, organic acids, anthocyanins, that contribute to their color. Especially, Mulberries have to some phytochemical compounds, such as anthocyanins, chlorogenic acid, rutin, and myricetin and there may help protect against chronic conditions like cancer, diabetes, and heart diseas (Sharma et al., 2013; Okatan, 2018). In the researches determined the chemicals, physicochemical properties in different species of mulberry (M. *nigra* and *M. rubra)* that is given Table 1 and 2). There were significant differences in terms of total polyphenol, total antioxidant and anthocyanin capacity, phenolic compounds and vitamin C contents of examined mulberry species in previous years (Table 1 and 2). Specially black mulberry have phenolic compounds such as widely prevailing the chlorogenic acid and catechins that may help protect against chronic conditions like cancer, diabetes, and heart diseas. This situation increases the importance of black mulberry fruit for human health.

Rosehip

Rosa genus includes more than 100 species, widely distributed in Europe, Asia, the Middle East and North America and members of the *Rosaceae* family have long been used rose leaves, flowers, and fruits have been used for thousands of years for their for food and medicinal purposes (Ercisli 2007). Rose hips are very rich in vitamin C, as well as good sources of phenolics, including flavonoids, anthocyanins among fruits and vegetables. In addition, rose hips contain other vitamins and minerals, carotenoids, tocopherol, bioflavonoids, fruit acids, tannins, pectin, sugars, organic acids, amino acids and essential oils. (Uggle et al., 2003; Uggla, and Gustavsson, 2005; Turkben et al, 2010). Bioactive compounds are known for their antioxidant properties and there are some studies that analyze the phenol content and composition of these compounds found in different *Rosa* species, especially *R. canina*. However, in a previous study, it was reported that the phenolic profile of roses varied variable quantitatively and qualitatively. Many of these studies are also given in the Tables 1 and 2. As seen in the tables, researchers identified ellagic acid, chlorogenic acid, ferulic acid and catechin as the major phenolics of *R. Canina.* (Salminen et al., 2005; Nowak, 2006; Adamczak et al., 2012; Tumbas et al., 2012; Demir et al., 2014). The total phenolic content, antioxidant and anthocyanin of Rosehip are higher that other berries. Their occurrence is influenced by cultivar selection, environmental factors such as light, temperature, and agricultural methods.

Red Raspberries

Raspberry (family: *Rosaceae*, genus *Rubus*, widely cultivated cultivar: *R. idaeus*), belongs to the varieties of red-colored *Rubus* fruits that grow in Europe (European red raspberries), North America (American diversity) and many different varieties and diversity in Asia and China. With today's interest in natural foods and healthy diets, the popularity of raspberries remains strong. Recent research supports the belief that raspberries are a particularly healthy part of human nutrition. Raspberries (*R. idaeus* L.) contain a large number of phenolic compounds with potential health benefits. They are juicy, a distinctive aroma and a good source of natural antioxidants. It is rich in vitamins and minerals raspberries, as well as anthocyanins, phenolic acid and other flavonoids (Beekwilder et al. 2005; Gulcin et al., 2011). Table 1-2 shows some biochemical compounds of the raspberry species. The antioxidant and anthocyanin capacity of raspberries, different to other berries, is correlated with various biochemical compounds that have antioxidant properties (Table 1-2). Phenolic compounds such as catechin ellagic acid, quercetin or gallic acid are thought to correlate higher with antioxidant capacity than ascorbic acid (Skrovankova et al., 2015). Raspberry with high phytochemical content showed increases antioxidant capacity

Blackberries

Blackberries (family: *Rosaceae*, genus *Rubus*, common cultivated variety: *Rubus fruticosus* L.) have a similar morphology to raspberries. Blackberry is famous for its fruit, which is known worldwide for its delicious taste, pleasant taste and nutritional profile. The blackberry fruits can be used in the industry for ice cream, juice, jam, marmalade, cake (Kafkas et al., 2006; Skrovankova et al., 2015). Compounds such as phytochemical compounds extracted from blackberry may also be used in the production of functional foods to increase their biological value. They can have a positive effect on uman health prevention of various diseases. Therefore, There is increasing interest in blackberry production in the World. They are a rich source of vitamins, polyphenols, minerals, and antioxidants and its potential uses in the processing different industry. Phenolic compounds, especially the concentration of high level, is a very important physiological process that determines the dessert fruit quality (Skrovankova et al., 2015: Gundogdu et al., 2016). Recent studies fruits of blackberry have demonstrated. The composition profiles of blackberry phytochemical compounds are qualitatively very different. The relevant phytochemical compounds in blackberries are given in Table 1-2. Rutin and gallic acid were the predominant phenolic compounds in blackberry. Antioxidant capacity of blackberries is influenced by several factors. Ascorbic acid is low levels other berries that is not an influential contributor to the antioxidant capacity. Therefore, phenolics influence antioxidant activity considerably. Research has shown the role of blackberry fruits in human health and nutrition. Accordingly, blackberry berries are becoming more popular and consumption is increasing.

Berberis

The barberry genus is commonly found across all parts of Europe and Asia that belongs to *Berberidaceae* family. *Berberis vulgaris* L. is well known for pharmacological properties and its consumption as food in most of the world (Imanshahidi & Hosseinzadeh, 2008; Gundogdu, 2013). It is a 100-180 cm thorny bush with obovate leaves, yellow flowers and rectangle red fruits. The shiny flowers are androgynous, which are typically found in composite pendant clusters or panicle with 10-20 flowers in each panicle. Barberry fruits have reddish-brown color and can reach up to 13 mm (Kafi et al., 2004; Khadivi-Khub, 2009).

Gooseberry

Gooseberry is the Ribes genus of the Grossulariaceae family of Saxifragales and belongs to the Grossularia subgenus. There are many species in the genus Grossularia. Of these, only one European species, called Ribes grossularia L. by Linne, was formerly described as gooseberry. Nowadays cultivated varieties; Ribes uva-crispa L. var. sativum DC. It is collected under the name (Agaoglu, 1986). Table 1-2 shows some biochemical compounds of the gooseberry species. The antioxidant and anthocyanin capacity of gooseberry, different to other berries, is correlated with various biochemical compounds that have antioxidant properties (Table 1-2).

Tabel 1. Total polyphenols, Antioxidant, Anthocyanin and Ascorbic acid contents of some berries.

Berries species	Total polyphenols mg GAE/100 g FW		Antioxidant mg/100 g		Anthocyanin mg/100 g		Ascorbic acid (vitamin C) mg/100 g FW	
	Values	References	Values	References	Values	References	Values	References
Strawberry (*Fragaria vesca* L.)	317,2- 717	Zheng et al., (2007); Skupień and Oszmiański, (2004); Doumett et al., (2011); Wang, et al., (2015)	7.98 - 242.5	Wang and Lin (2000); Buřičová et al., (2011); Yildiz et al., (2014)	25.11 - 241.9	Zorenci et al., (2016); Yildiz et al., (2014); Wang, et al., (2015)	28,04-80,40	Jabłońska-Ryś et al., (2009); Oumett et al., (2011); Yildiz et al., (2014); Jurgiel-Małecka et al., (2017); Gorguc et al., (2019)
Red Currant (*Ribes rubrum)*	5,68-10,30	Okatan, (2016)	12,67-29,29	Aneta et al., 2013 Villano et al., (2007)	7,5	Chiang et al., (2013)	35,41- 1410,60	Okatan, (2016); Aneta et al., (2013); Pantelidis vd. (2007),
Black Currant (*Ribes nigrum*)	5,27-17,17	Okatan, (2016)	73,55	Mikulic-Petkovsek et al., (2012)	14,65-15,42	Rubinskiene et al., (2005)	52,97-2779,30	Gerçekçioğlu et al., (2009); Okatan, (2016)
Blueberry (*Vaccinium* spp.)	158,4- 2784,45	Ercisli et al., (2010); Okatan, (2018); Aprile et al., (2019); Sellepan et al., (2002)	5.63- 7.60	Skrovankova,et al., (2015); Wang et al., (2017); Sellepan et al., (2002); Bunea et al., (2011); Rodrıgues et al., (2011)	57–503	Stevensona and Scalzob, (2012); Skrovankova, et al., (2015); Prior et al., (2001); Wolfe et al., (2008); Rodrıgues et al., (2011)	4,54- 100	Skupień et al., (2006); Skrovankova et al., (2015); Kim et al., (2017); Guofang et al., (2019);
White mulberry (*Morus alba* L.)	104,8- 213,5	Ozgen et al., (2009)	6.170- 16.16	Eyduran et al., (2015); Gundogdu et al., (2016)	4.494-6.167	Gündoğdu et al., (2011)	15,37-17,42	Imran et al., (2010); Gecer et al., (2016)
Black mulberry (*Morus nigra* L.)	158,4- 2784,45	Ercisli et al., (2010); Okatan, (2018) Aprile et al., (2019)	13.999 - 32.9	Gundogdu et al., (2011); Negro et al., (2019); Okatan, (2018)	173.1- 830	Kähkönen et al., (2001); Ozgen et al., (2009); Kamiloglu et al., (2013)	10,123- 21,80	Lale and Ozcagıran, (1996); Karacalı, I., (2000); Gundogdu et al., (2011); Ercıslı and Orhan , (2008)
Rosehip (*Rosa canina* L.),	102-3151	Ercisli and Yılmaz, (2011); Demir et al., (2014); Koczka et al., (2018)	19.38-97.468	Sasikumar et al., (2012); Roman et al., (2013); Bhat et al., (2018)	176–9.600	Ercisli, (2007); Fattahi et al., (2012); Roman et al., (2013)	65,75 -4000	Demir et al., (2014); Celik et al., (2009); Barros et al., (2010); Ercisli, (2007)
Raspberry (*Rubus ideaus* L.)	113.73-1822	de Ancos et al., (2000); Wada and Ou, (2002); Proteggente et al., (2002); Karjalainen, (2005); Sarıburun et al., (2010)	35. 0-162.1	Wang and lin, (2000); Barroset al., (2011); Bobinaitė et al., (2012)	15.1-608.24	Kostecka-Gugała et al., (2015); Buřičová et al., (2011); Pantelidis et al., (2007)	7,4- 36	Beekwilder et al., (2005); Tosun et al., (2009); Miret et al., (2016); Tănase et al., (2016)
Blackberries (*Rubus fructicosus* L.),	48.9-690.2	Benvenutiet al., (2004); Q. You et al., (2011); Giovanelli et al., (2012); Cineasa et al., (2015)	38.2- 432	Wang and Lin, (2000); Reyes-Carmona et al., (2005)	35.1 – 230.74	Kostecka-Gugała et al., (2015); Pantelidis et al., (2007); Kähkönen et al., (2001)	10,28- 70.41	Koca and Karadeniz, (2009); Ochmian et al., (2009); Tamer, (2012); Zia-Ul-Haq et al., (2014); Gundoğdu et al., (2016)
Berberis vulgaris L.	11.04- 3450	Sasikumar et al., (2012); Berenji Ardestani et al., (2013); Sharifi and Poorakbar, (2015)	8.731-90,63	Sasikumar et al., (2012); Okatan et al., 2019	10,22-77,87	Laleh et al., (2006)	10,83-135	Sood et al., (2010); Motalleb et al., (2005)
Gooseberry (*Ribes grossularia* L.).	290- 2611	Wang and Lin, (2000); Pantelidis et al., (2007)	16.1 – 87.05	Pantelidis et al., (2007); Chanyotha et al., (2019); Laczkó-Zöld et al., (2018)	1.3-152.2	de Ancos et al., (2000); Narváez-Cuenca et al., (2014); Laczkó-Zöld et al., (2018)	14.3 – 169.7	Demir et al., (2003); Nishiyama et al., (2004); Pantelidis et al., (2007)

Tabel 2. Major phenolic compounds of berries.

Berries	Major Phenolic Compounds (mg 100 g^{-1})	References
Strawberry (*Fragaria vesca* L.)	**Ellagic acid;** 9,7- 34,5 **Gallic acid;** 5,6-44 **Catechin;** 10,1- 98,8 **Ferulic acid;** 1,5- 5,1 **Quercetin;** 5,2–81	Tosun and Artık (1998); Kähkönen et al., (2001);); Buendia et al., (2010); Aaby et al., (2012); V, et al., 2014;Karaağaç et al., (2019);
Black Currant (*Ribes nigrum*)	**Rutin:** 15,71-35,41 **Catechin:** 10,24 **Chlorogenic:** 18,35-65,49 **Quercetin:** 1,50-2,20 **p-Coumaric:** 0,71-1,66	Okatan et al., (2017)
Red Currant (*Ribes rubrum*)	**Rutin:** 7,23-18,52 **Catechin:** 7,09 **Chlorogenic:** 2,38 **Quercetin:** 2,01-2,29 **p-Coumaric:** 0,04	Okatan et al., (2017)
Blueberry (*Vaccinium* spp.)	**Catechin;** 29,28- 387,48 **Quercetin;** 5,88- 160 **Gallic acid;** 1,53- 258,9 **Ferulic acid;** 3,02- 5,78 **Ellagic acid;** 1,12- 6,02	Häkkinen et al., (1999); Häkkinen et al., (2000); Sellepan et al., (2002); Tosun and Yuksel, (2003)
White mulberry (*Morus alba* L.)	**Gallic acid;** 8,50-21-56 **Ellagic acid;** 3,83-11,70 **Catechin;** 0,56-9,09 **Chlorogenic;** 15,48 -37,24 **Rutin;** 22,50 -37,77 **Chlorogenic;** 5,48-37,24	Gundogdu et al., (2011); Mahmood et al., (2012); Natic et al., (2015); Gundogdu et al., (2018)
Black mulberry (*Morus nigra* L.)	**Ellagic acid;** 4,34 - 22,7 **Gallic;** 15,96 -40,14 **Caffeic;** 2,01-12,11 **Chlorogenic;** 11,67-53,13 **Rutin;** 6,42 -29,52	Gundogdu et al.(2011); Mahmood et al. (2012); Butkhup et al., (2013); Okatan, (2018); Özgen et al. (2009); Sanchez et al. (2014)
Rosehip (*Rosa canina* L.),	**Catechin;** 7,18-50,46 **Ferulic acid;** 4,03-10,55 **Chlorogenic acid;** 4,57-12,11 **Caffeic acid;** 6,12-9,38	Salminen et al., (2005); Nowak, (2006); Adamczak et al., (2012); Demir et al., (2014);
Raspberry (*Rubus ideaus* L.)	**Ellagic acid;** 7,7-19,7 **Catechin;** 6,5-42,43 **gallic acid;** 3,00- 14,6 **ferulic acid;** 1,00-4,90 **quercetin;** 1,52- 15,1	Adina et al., (2017); Gulcin et al., (2011); Pelc et al., (2009); Gevrenova et al., (2013); Pantelidis et al., (2007)
Blackberries (*Rubus fructicosus* L.),	**Catechin;** 111,599- 438,970 **Ellagic acid;** 10,610- 51,506 **Gallic acid;** 2,198- 9,428 **Caffeic acid;** 1,159- 12,897 **Rutin;** 0,972- 22,77 **Ferulic acid;** 0,389- 2,745	Gudej and Tomczyk, (2004); Buřičová et al., (2011); Zia-Ul-Haq et al., (2014); Gundoğdu et al., (2016)
Berberis vulgaris L.	**Gallic acid:** 0.132 **Catechin:** 0.218 **Chlorogenic acid:** 0.752 **Caffeic:** 0.095 **Syringic:** 0.032	Gundogdu, (2013)
Gooseberry (*Ribes grossularia* L.).	**Caffeic acid:** 2,22 **Kaempferol:** 28,98 **p-coumaric acid:** 6,99 **Quercetin:** 6,32 **Resveratrol:** 23,46 **Rutin:** 15,73	Chiang et al., (2013)

Conclusion

Berries have chemicals that can cure many diseases, and recently scientists have focused on these fruits. In particular, the drugs obtained from these fruits are being researched against cancer, which is the biggest disease of today. They are also consumed by people because of their unique colors, shapes, and tastes (as in the food industry, pastry and cake, juice, liquor, tea, etc.). Recently, garden installations related to berry fruits have increased. Television and advertisements consistently produce news about these fruits. This has made people susceptible to berries.

References

Adina, F., Cecilia, G., Felicia, G., Carmen, D., Ovidiu, T., (2017). Identification and Quantification of Phenolic Compounds from Red Currant (Ribes rubrum L.) and Raspberries (Rubus idaeus L.). International Journal of Pharmacology, Phytochemistry and Ethnomedicine. Vol. 6, pp 30-37

Aaby, K., Mazur, S., Nesic, A., Skrede, G. (2012). Phenolic compounds in strawberry (Fragaria x ananassa Duch.) fruits: Composition in 27 cultivars and changes during ripening. Food Chemistry. 86–97.

Adamczak, A., Buchwald, W., Zielinski, J., Mielcarek, S. (2012). Flavonoid and organic acid content in rose hips (Rosa L., sect. Caninae dc. Em. Christ.). Acta Biologica Cracoviensia Series Botanica, 54(1).

Ağaoğlu, Y. S. (1986). Üzümsü Meyveler. Ankara Üniversitesi Ziraat Fakültesi Yayınları, No:984, 377s, Ankara.

Álvarez-Fernández, M.A., Ortega, R.H.,Cerezo, A.,Trancoso, AM., Garcia-Parrilla, MC., (2014). Effects of the strawberry (Fragaria ananassa) purée elaboration process on non-anthocyanin phenolic composition and antioxidant activity. Food Chemistry 164:104–112. DOI: 10.1016/j.foodchem.2014.04.116

Aneta, W., Jan, O., Magdalena, M., & Joanna, W. (2013). Phenolic profile, antioxidant and antiproliferative activity of black and red currants (Ribes spp.) from organic and conventional cultivation. International Journal of Food Science & Technology, 48(4), 715-726.

Beekwilder, J., Jonker, H., Meesters, P., Hall., R.D., van der Meer, I., De Vos, R. (2005). Antioxidants in Raspberry: On-Line Analysis Links Antioxidant Activity to a Diversity of Individual Metabolites. ournal of Agricultural and Food Chemistry 53(9):3313-20.

Bhatt, L.R., Wagle, B., Adhikari, M., Bhusal,S., Giri, A., Bhattarai, S. (2018). Antioxidant Activity, Total Phenolic and Flavonoid Content of Berberis aristata DC. and Berberis thomsoniana C.K. Schneid. from Sagarmatha National Park, Nepal. Pharmacogn J. 2018; 10(6) Suppl: s167-s171.

Barros L., Carvalho A.M., Morais J.S. and Ferreira I.C.F.R. (2010). Strawberry-tree, blackthorn and rose fruits: Detailed characterization in nutrients and phytochemicals with antioxidant properties. Food Chem. 120: 247–254

Benvenuti S., Pellati F., Melegarı M., and Bertelli D. (2004). Polyphenols, anthocyanins, ascorbic acid, and radical scavenging activity of Rubus, Ribes, and Aronia. Journal of Food Science 69: 164–169.

Berenji Ardestani, S., Sahari, M. A., Barzegar, M. and Abbasi, S. (2013).“Some physicochemical properties of Iranian native barberry fruits (abi and poloei): Berberis integerrima and Berberis vulgaris”. Journal of food and Pharmaceutical Sciences,1, pp 67- 74.

Bobinaitė R, Vikelis P, Rimantas-Vensutonis P (2012). Variation of total phenolics, anthocyanins, ellagic acid and radical scavenging capacity in various raspberry (Rubus spp.) cultivars. Food Chem 132: 1495-1501.

Brennan, R. M. (2008). Currants and Gooseberries, Temperate Fruit Crop Breeding, J.F. Hancock (ed.), Chapter 6, 177-196, Scotland, UK.

Butkhup, L.; Samappito, W.; Samappito, S. (2013) Phenolic composition and antioxidant activity of whyte mulberry (Morus alba L.) fruits. Int. J. Food Sci. Technol., 48, 934–940.

Buendia, B., Gil, M. I., Tudela, J. A., Gady, A. L., Medina, J. J., Soria, C., et al., (2010). HPLC-MS analysis of proanthocyanidin oligomers and other phenolics in strawberry cultivars. Journal of Agricultural and Food Chemistry, 58, 3916–3926.

Bunea, A., Rugina D.O., Pintene, A.M., Sconta, Z., Bunea C.I., Socaıcu, C., (2011). Comparative Polyphenolic Content and Antioxidant Activities of Some Wild and Cultivated Blueberries from Romania. Not Bot Horti Agrobo, 2011, 39(2):70-76.

Buřičová, L., M. Andjelkovic, A. Čermáková, Z. Réblová, O.Jurček, E. Kolehmainen, R. Verhé, F. Kvasnička (2011). Antioxidant capacities and antioxidants of strawberry, blackberry and raspberry leaves. Czech J. Food Sci. 29:181–18

Cassidy, A., Mukamal, K. J., Liu, L. (2013). High anthocyanin intake is associated with a reduced risk of myocardial infarction in young and middle-aged women. Circulation, 127(2), 188‑196.

Castillo del Ruiz, M. Z. and Dobson, G. (2002). Varietal differences in terpene composition of blackcurrant (Ribes nigrum L.) berries by solid phase microextraction/gas chromatography. Journal of Agricultural and Food Chemistry, 82, 1510-1515.

Casto, B.C., Kresty, L.A., Kraly, C.L., Pearl, D.K., Knobloch, T.J. (2002). Chemoprevention of oral cancer by black raspberries. Anticancer Res. 22, 4005- 4015.

Carlton, P.S., Kresty L.A., Siglin, J.C., Morse, M.A., Lu, J. (2001). Inhibition of n-nitrosomethylbenzylamine-induced tumorigenesis in the rat esophagus bu dietary freeze-dried strawberries. Carcinogenesis. 22, 441-446.

Celik F., Kazankaya A. and Ercisli S. (2009). Fruit characteristics of some selected promising rose hip (Rosa spp.) genotypes from Van region of Turkey. Afr. J. Agric. Res. 4(3): 236-240.

Cieslik, E., Greda, A., Adamus, W. (2006) Content of polyphenols in fruit and vegetables. Food Chemistry 94: 135–142.

Chanyotha, A., Techametheekul, K.W., Setthayanond, J., (2019). DDevelopment and Antioxidant Activity Analysis of Bio-Cellulose Containing Indian Gooseberry Extract. International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-8, Issue-3S, February 2019.

Chiang, C. J., Kadouh, H., & Zhou, K. (2013). Phenolic compounds and antioxidant properties of gooseberry as affected by in vitro digestion. LWT-Food Science and Technology, 51(2), 417-422.

Correa-Betanzo, J., Allen-Vercoe, E., McDonald, J., Schroeter, K., Corredig, M., Paliyath, G. (2014). Stability and biological activity of wild blueberry (Vaccinium angustifolium) polyphenols during simulated in vitro gastrointestinal digestion. Food Chem, 165, 522–531.

Dvaranauskaitė, A., Venskutonis, P. R., Raynaud, C., Talou, T., Viškelis, P., & Sasnauskas, A. (2009). Variations in the essential oil omposition in buds of six blackcurrant (Ribes nigrum L.) cultivars at various development phases.Food Chemistry, 114(2), 671-679.

de Ancos, B., Gonzalez, E. M., & Cano, M. P. (2000). Ellagic acid, vitamin C, and total phenolic contents and radical scavenging capacity affected by freezing and frozen storage in raspberry fruit. Journal of Agricultural and Food Chemistry, 48, 4565–4570.

Demir F. and Özcan M. 2001. Chemical and technological properties of rose (Rosa canina L.) fruits grown wild in Turkey. J. Food Eng. 47: 333–336

Demir, F., and Kalyoncu, I. H. (2003). Some nutritional, pomological and physical properties of cornelian cherry (Cornus mas L.). Journal of Food Engineering, 60, 335–341

Demir, N.; Yildiz, O.; Alpaslan, M.; Hayaloglu, A. (2014). Evaluation of volatiles, phenolic compounds and antioxidant activities of rose hip (Rosa L.) fruits in Turkey. LWT Food Sci. Technol. 2014, 57, 126–133

De Souza, V.R.; Pereira, P.A.; da Silva, T.L.; de Oliveira Lima, L.C.; Pio, R.; Queiroz, F. (2014). Determination of the bioactive compounds, antioxidant activity and chemical composition of Brazilian blackberry, red raspberry, strawberry, blueberry and sweet cherry fruits. Food Chem., 156, 362–368.

Diaconeasa Z., Ranga F., Rugina, D., Leopold, L., Pop, O., Vodnar, N., Cubiu, L., Socaciu, C. (2015). Phenolic Content and Their Antioxidant Activity in Various Berries Cultivated in Romania. Bulletin UASVM Food Science and Technology 72(1).

Doumett, S., Fibbi, D., Cincinelli, A., Giordani, E., Nin, S., and Del Bubba, M. (2011). Comparison of nutritional and nutraceutical properties in cultivated fruits of Fragaria vesca L. produced in Italy. Food Res. Int. 44, 1209–1216. https://doi.org/10.1016/j.foodres.2010.10.044

Ercişli, S., (2007). Chemical composition of fruits in some rose (Rosa spp.) species. Food Chemistry 104:1379-1384.

Ercisli, S.; Orhan, E. (2007), Chemical composition of white (Morus alba), red (Morus rubra) and black (Morus nigra) fruits. Food Chem. 103, 1380–1384.

Ercisli, S.; Orhan, E. Some physico-chemical characteristics of black mulberry (Morus nigra L.) genotypes from Northeast Anatolia region of Turkey. Sci. Hortic. 2008, 116, 41–46.

Ercisli, S.; Tosun, M.; Duralija, B.; Voca, S.; Sengul, M.; Turan, M. (2010). Phytochemical content of some black (Morus nigra L.) and purple (Morus rubra L.) mulberry genotypes. Food Technol. Biotechnol. 2010, 48, 102–106.

Fattahi S., Jamei R. and Hosseini Sarghein S. 2012. Antioxidant and antiradicalic activity of Rosa canina and Rosa pimpinellifolia fruits from West Azerbaijan. Iran. J. Plant Physiol. 2(4): 523–529.

Gecer, M.K., Akin, M., Gundogdu, M., Eyduran, S.P, Sezai Ercisli, and Eyduran,E., (2016). Organic acids, sugars, phenolic compounds, and somehorticultural characteristics of black and white mulberry accessions from Eastern Anatolia. J. Plant Sci. 96: 27–33.

Gerçekçioğlu, R., Bayazıt, S., Edizer, Y., Çekic, Ç., (2009). Performance of some Currant (Ribes ssp.) Varieties in Tokat Ecology. III. National Grape Fruits Symposium, 308-313, Kahramanmaraş.

Gevrenova, R., Badjakov, I., Nikolovac, M., Doichinova, I., (2013). Phenolic derivatives in raspberry (Rubus L.) germplasm collection in Bulgaria. Biochemical Systematics and Ecology 50:419–427.

Giovanelli, G., Brambilla, A., Rizzolo, A., and Sinelli, N. (2012). Effects ofblanching pre-treatment and sugar composition of the osmotic solution on physico-chemical, morphological and antioxidant characteristics of osmodehydrated blueberries (Vaccinium corymbosum L.). Food Res. Int. 49, 263–271. doi: 10.1016/j.foodres.2012.08.015

Gren, T. P.; Wyzgoski, F. J.; Reese, R. N.; Rinaldi, P. L.; Ozgen, M.; Tulio, A. Z.; Miller, A. R.; Scheerens, J. C. (2005). Identification of biologically active metabolic constituents of black raspberry using HPLC, NMR and multiple correlations with biochemical and bioassay data. AGFD-086.

Gorguc, A., Yıldırım, A., Takma, D., Erten, E.S., Yılmaz, F.M. (2014). Physical, chemical, bioactive and aroma properties of commercial strawberry cultivars grown in Aydın province. Harran Tarım ve Gıda Bilimleri Dergisi, 23(2): 131-141.

Gudej,J., and Tomczyk, M. (2004). Determination of Flavonoids, Tannins and Ellagic acid in leaves from Rubus L. species. Archives of Pharmacal Research 27(11):1114-9 .DOI: 10.1007/BF02975114

Gulcin, I., Topal, F., Çakmakcı, R., Bilsel, M., Goren, A.C., Erdogan, U., (2011). Pomological Features, Nutritional Quality, Polyphenol Content Analysis, and Antioxidant Properties of Domesticated and 3 Wild Ecotype Forms of Raspberries (Rubus idaeus L.). Journal of Food Science. Vol. 76, Nr. 4.

Gundogdu M, Muradoglu F, Gazioglu Sensoy RI, Yilmaz H (2011). Determination of fruit chemical properties of Morus nigra L., Morus alba L. and Morus rubra L. by HPLC. Sci HorticAmsterdam 132: 37-41.

Gundogdu, M. (2013). Determination of Antioxidant Capacities and Biochemical Compounds of Berberis vulgaris L. Fruits. Advances in Environmental Biology, 7(2): 344-348.

Gundogdu, M., Kan, T., Canan, I (2016). Bioactive and antioxidant characteristics of blackberry cultivars from East Anatolia. Turk J Agric For (2016) 40: 344-351

Gundogdu, M., Tunçtürk, M.,Berk, S., Şekeroğlu, N., Gezici,S., (2018). Antioxidant Capacity and Bioactive Contents of Mulberry Species from Eastern Anatolia Region of Turkey. Indian Journal of Pharmaceutical Education and Research | Vol 52 | Issue 4 (Suppl) | Oct-Dec,

Guofang, X., Xiaoyan, X., Xiaoli, Z., Yongling, L., Zhibing, Z. (2019). Changes in phenolic profiles and antioxidant activity in rabbiteye blueberries during ripening. Int. J. Food Pro. 22 (1), 320–329. doi: 10.1080/10942912.2019.1580718.

Halliwell, B. (1996). Antioxidants in human health and disease. Ann. Rev. Nutr. 16, 33–50.

Häkkinen, S., Heinonen, M., Kärenlampi, S., Mykkänen, H., Ruuskanen, J., and Törrönen, R., (1999). Screening of Selected Flavonoids and Phenolic acids in 19 Berries. Food Research Int. 32:345-353.

Häkkinen, S.H., Kärenlampi, S.O., Mykkänen, H.M., and Törrönen, A.R., (2000). Influence of Domestic Processing and Storage on Flavonol Contents in Berries. J. Agric. Food Chem. 48:2960-2965.

Imanshahidi, M. and H. Hosseinzadeh. 2008. Pharmacological and therapeutic effects of Berberis vulgaris and its active constituent, berberine. Phytotherapy Research, 22(8): 999-1012.

Imran M, Khan H, Shah M, Khan R, Khan F (2010). Chemicalcomposition and antioxidant activity of certain Morus species. Journal of Zhejiang University Science B 11: 973-980.

Jabłońska-Ryś, E., Zalewska-Korona, M., and Kalbarczyk, J. (2009). Antioxidant capacity, ascorbic acid and phenolics content in wild edible fruits. J. Fruit Ornam. Plant Res. 17, 115–120.

Jurgiel-Małecka, G., Gibczyńska, M., Siwek, H., and Buchwał, A. (2017). Comparison of fruits chemical composition of selected cultivars wild strawberry (Fragaria vesca L.). Eur.J.Hortic.Sci. 82 (4) 204-210 | DOI: 10.17660/eJHS.2017/82.4.6.

Kafi, M., A. Balandary, M.H. Rashed-Mohasel, A. Koochaki and A. Molafilabi. 2004. Berberis: Production and Processing. Zaban va adab Press, Iran, pp. 1-209 (in Persian).

Kafkas, E.; Kosar, M.; Turemis, N.; Baser, K.H.C. (2006). Analysis of sugars, organic acids and vitamin C contents of blackberry genotypes from Turkey. Food Chemistry, v.97, p.732-736,

Kamiloglu, S., Serali, O., Unal, N., and Capanoglu, E., (2013). Antioxidant activity and polyphenol composition of black mulberry (Morus nigra L.) products. Journal of Berry Research 3 (2013) 41–51

Karaagac, H.E., and Ucurum, H.O., (2019). Investigation Of Phenolic Composition of Organically-Grown Strawberry and Blueberry. GIDA (44 (5): 794-801 doi: 10.15237/gida.GD19049.

Karacali, I., (2000). The Storage and Handling of Horticultural Crops, Ege University, Agricultural Faculty, Turkey (in Turkish).

Karakaya, S., and Kavas, A. (1999). Antimutagenic activities of some foods. Journal of the Science of Food and Agriculture, 79(2), 237-242

Katsube, N., Iwashita, K., Tsushida, T., Yamaki, K., ve Kobori, M. (2003). Induction of apoptosis in cancer cells by bilberry (Vaccinium myrtillus) and the anthocyanins. J. Agric. Food Chem. 51-68-75.

Khadivi-Khub, A. 2009. Pomology. Agriculture Education Press, Tehran, Iran (In Farsi).

Kim, M., Na., H., Kasai, H., Kawai, K., Li, Y.,Yang,M. (2017). Comparison of Blueberry (Vaccinium spp.) and Vitamin C via Antioxidative and Epigenetic Effects in Human. J Cancer Prev. 2017 Sep; 22(3): 174–181.

Koca, I., Karadeniz, B. (2009). Antioxidant properties of blackberry and blueberry fruits grown in the Black Sea Region of Turkey. Scientia Horticulturae, v. 121, p. 447-450.

Koczka, N., Stefanovits-Bányai, E., Ombódi, A., (2018). Total Polyphenol Content and Antioxidant Capacity of Rosehips of Some Rosa Species. Medicines., 5, 84.

Kostecka-Gugała, A., Ledwożyw-Smoleń, I., Augustynowicz, J., Wyżgolik, G., Kruczek, M., Kaszycki, P. (2015). Antioxidant properties of fruits of raspberry and blackberry grown in central Europe. Open Chem., 2015; 13: 1313–1325.

Kresty, L.A., Morse, M.A., Morgan, C., Carlton, P.S., Lu, J. (2001). Chemoprevention of esophageal tumorigenesis bu dietary administration of

lyophilized black raspberries. Cancer Res. 61, 6112-6119.
Kähkönen, M.P., Hopia, A. I., and Heinonen, M., 2001. Berry. Phenolics and Their Antioxidant Activity J. Agric. Food Chem, (49): 4076-4082.
Laczkó-Zöldi E., Komlósi, A., Ülke, T., Fogaras, E., Croitoru, M., Fülöp, I., Domokos, E., Ştefãnescu, R., Varga, E., (2018). Extractabılıty Of Polyphenols From Black Currant, Red Currant And Gooseberry AndTheır Antıoxıdant Actıvıty. Acta Biologica Hungarica 69(2), pp. 156–169 (2018) DOI: 10.1556/018.69.2018.2.5.
Laleh, G. H., Frydoonfar, H., Heidary, R., Jameei, R., & Zare, S. (2006). The effect of light, temperature, pH and species on stability of anthocyanin pigments in four Berberis species. Pakistan Journal of Nutrition, 5(1), 90-92.
Lale H, Özçağıran R (1996). Dut türlerinin pomolojik, fenolojik ve bazı meyve kalite özellikleri üzerinde bir araştırma. Derim 13: 177-182 (in Turkish).
Le Quere, J. L., & Latrasse, A. (1990). Composition of the essential oils of black currant buds (Ribes nigrum L.). Journal of Agricultural and Food Chemistry, 38(1), 3-10.
Mackerras, D. (1995). Antioxidants and health. Fruits and vegetables or supplements. Food Australia. 47S, 3-23.
Mahmood T, Anwar F, Abbas M, Saari N. (2012). Effect of Maturity on phenolics (phenolic acids and flavonoids) profile of strawberry cultivars and mulberry species from Pakistan. International Journal of Molecular Sciences. 2012;13(4):4591-607
Manach C, Scalbert A, Morand C, Rémésy C, Jiménez L (2004) Polyphenols: food sources and bioavailability. Am J Clin Nutr 79: 727-747.
Miguel, M. G. (2011). Anthocyanins: Antioxidant and/or anti-inflammatory activities. Journal of Applied Pharmaceutical Science, 1(6), 7-15.
Mikulic- Petkovsek, M., Schmitzer, V., Slatnar, A., Stampar, F., & Veberic, R. (2012). Composition of sugars, organic acids, and total phenolics in 25 wild or cultivated berry species. Journal of food science, 77(10), C1064- C1070.
Milivojević, J., Maksimović, V., Nikolić, M, Bogdanović, J., Maletić, R., Milatović, D, (2011). Chemical and antioxidant properties of cultivated and wild Fragaria and Rubus berries. J Food Qual 34: 1-9.
Miret, J.A., Munné-Bosch, S. (2016). Abscisic acid and pyrabactin improve vitamin C contents in raspberries. Food Chemistry 203 :216–223.
Motalleb, G., Hanachi, P., Kua, SH., Fauziah, O. and Asmah, R. (2005). "Evaluation of phenolic content and total antioxidant activity in Berberis vulgaris fruit extract". Journal of Biological Science, 5 (5): pp 648-653
Moyer, R.A., Hummer, K.I., Fınn, C.I., Frei, B., and Wroldstad, R.E. (2002). Anthocyanins, Phenolics, and Antioxidant Capacity in Diverse Small Fruits: Vaccinium, Rubus, and Ribes. J. Agric. Food Chem. 2002, 50, 519−525.
Nadulski, R., Masłowski, A., Mazurek, A., Sobczak, P., Szmigielski, M., Sobczak, W.Z., Niedziółka, I., Mazur, J. (2019). Vitamin C and lutein content of northern highbush blueberry (Vaccinium corymbosum L.) juice processed using freezing and thawing. Journal of Food Measurement and Characterization, 13:2521–2528.
Narváez-Cuenca, C.E., Mateus-Gómez, A., Restrepo-Sánchez, L.P., Antioxidant capacity and total phenolic content of air-dried cape gooseberry (Physalis peruviana L.) at different ripeness stages. gronomía Colombiana 32(2), 232-237, 2014.
Natic MM, Dabic DC, Papetti A, Fotiric Akšic MM, Ognjanov V, Ljubojevic M, (2015). in mulberry (Morus alba L.) fruits grown in Vojvodina, North Serbia. Food Chemistry. 2015;171:128-36.
Negro, C., Aprile, A., Bellis L.D., and Miceli,A. (2019). Nutraceutical Properties of Mulberries Grown in Southern Italy (Apulia). Antioxidants (Basel) 2019, 8, 223;
Nowak, R. (2006). Comparative study of phenolic acids in pseudofruits of some species of roses. Acta Poloniae Pharmaceutica, 63, 281e288.
Okatan, V. (2016). The effects of dıfferent growıng systems on the yıeld and qualıty of currant cultıvatıon. Master's thesis. Süleyman Demirel University, Institute of Science.
Okatan, V. (2018). Phenolic compounds and phytochemicals in fruits of black mulberry (Morus nigra L.) genotypes from the Aegean region in Turkey. Folia Hort. 30(1), 2018, 93-101
Okatan, V., Gündoğdu, M., Güçlü, S. F., Çelikay, A., Özaydın, A. M. Ç., Korkmaz, N., Aşkın, M. A. (2017). Phenolic Profiles of Currant (Ribes spp.) Cultivars. YYU J. Agr. Sci, 27(2), 192-196.
Okatan, V., Colak, A.M. (2019). Chemical and phytochemical content of barberry (Berberis vulgaris L.) fruit genotypes from sivasli district of usak province of western Turkey. Pakistan Journal of Botany; ISSN 0556-3321; Worldcat; v. 51(1); p. 165-170.
Ochmian I, Grajkowski J, Skupień K (2009a). Influence of substrate on yield and chemical composition of highbush blueberry fruit cv. 'Sierra'. J Fruit Ornam Plant Res 17: 89–100
Ozgen M., Serçe S., Kaya C., (2009). Phytochemical and antioxidant properties of anthocyanin-rich Morus nigra and Morus rubra fruits. Sci. Hortic. 119(3), 275-279.
Ouimette P., Vogt D., Wade M., Tirone V., Greenbaum M. A., Kimerling R. (2011). Perceived barriers to care among veterans' health Administration patients with posttraumatic stress disorder. Psychol. Serv. 8 212–223. 10.1037/a0024360.

Qi,Y., Baowu, Wang, F. C., Zhiliang, H., Xi, W., Pengju, G. L. (2011). Comparison of anthocyanins and phenolics in organically and conventionally grown blueberries in selected cultivars, Food Chemistry, 125 (1) 201-208.

Pantelidis GE, Vasilakakis M, Manganaris GA, Diamantidis GR. (2007). Antioxidant capacity, phenol, anthocyanin and ascorbic acid contents in raspberries, blackberries, red currants, gooseberries and cornelian cherries. Food Chem 102:777–83.

Pelc, M., Przybył, , J.L., Kosakowska, O., Szalacha, E., Szymborska, I., Węglarz, Z. (2009). Genetic and Chemical Variability of Wild Red Raspberry (Rubus idaeus L.) Growing in Poland. 4th IS on Breeding Research on Medicinal and Aromatic Plants (ISBMAP 2009) Eds.: Baričevič et al. Acta Hort. 860, ISHS 2010.

Píry, J., Príbela, A., Ďurčanská, J., & Farkaš, P. (1995). Fractionation of volatiles from blackcurrant (Ribes nigrum L.) by different extractive methods.Food chemistry, 54(1), 73-77.

Prior, R.L., Lazarus, S.A., Cao, M., Muccitelli, H., Hammerstone, F. (2001). Identification of Procyanidins and Anthocyanins in Blueberries and Cranberries (Vaccinium Spp.) Using High-Performance Liquid Chromatography/Mass Spectrometry. J. Agric. Food Chem. 2001, 49, 1270−1276.

Proteggente, A. R., Pannala, A. S., Paganga, G., Buren, L. V., Wagner, E., Wiseman, S., Rice-Evans, C.A. (2002). The antioxidant activity of regularly consumed fruit and vegetables reflects their phenolic and vitamin C composition. Free radical research, 36(2), 217-233.

Reyes-Carmona J., Yousef G.G., Martinez-Peniche R.A., Lila M.A. (2005): Antioxidant capacity of fruit extracts of blackberry (Rubus sp.) produced in different climatic regions. Journal of Food Science, 70: 497–503

Rubinskiene, M., Viskelis, P., Jasutiene, I., Viskeliene, R., & Bobinas, C. (2005). Impact of various factors on the composition and stability of black currant anthocyanins. Food research international, 38(8-9), 867-871.

Rodrigues, E., Poerner, N., Rockenbach, I.V., Gonzaga, L.V., Mendes, C.B., Fett, R. (2011). Phenolic compounds and antioxidant activity of blueberry cultivars grown in Brazil Compostos fenólicos e atividade antioxidante de cultivares de mirtilo produzidas no Brasil. Ciênc. Tecnol. Aliment., Campinas, 31(4): 911-917,2011

Roman I., Stanila A. and Stanila S. (2013). Bioactive compounds and antioxidant activity of Rosa canina L. biotypes from spontaneous flora of Transilvania. Chem. Cent. J. 7(73): 2-10

Sanchez E.M., Calın-Sanchez A., Carbonell-Barrachina A.A., Melgarejo P., Hernandez F., Martinez-Nicolas J.J., 2014. Physicochemical characterization of eight Spanish mulberry clones: Processing and fresh market aptitudes. Int. J. Food Sci. Technol. 49, 477-483.

Salminen, J. P., Karonen, M., Lempa, K., Liimatainen, J., Sinkkonen, J., Lukkarinen, M., et al. (2005). Characterisation of proanthocyanidin aglycones and glycosides from rose hips by high-performance liquid chromatographyemass spectrometry, and their rapid quantification together with vitamin C. Journal of Chromatography A, 1077, 170e180.

Scalzo, J., Stevenson, D., Hedderley, D. (2013). Blueberry estimated harvest from seven new cultivars: Fruit and anthocyanins. Food Chem, 139, 44–50.

Schwartz, J.L. (1996). The dual roles of nutrients as antioxidants and prooxidants: their effects on tumorcell growth. J. Nutr. 126S, 1221-1227.

Sellapan S, Akoh CC, Krewer G, (2002). Phenolic Compounds and Antioxidant Capacity of GeorgiaGrown Blueberries and Blackberries. Journal of Agricultural and Food Chemistry, 50,2432–2438.

Sharifi, F., Poorakbar, L., (2015). The survey of antioxidant properties of phenolic compounds in fresh and dry hybrid Barberry fruits. Cumhuriyet University Faculty of Science Science Journal (CSJ), Vol. 36, No: 3 Special Issue (2015).

Sharma S., Ali A, Ali J., Sahni J.K, Baboota S., (2013). Rutin: therapeutic potential and recent advances in drug delivery. Expert Opin Investig Drugs. 2013 Aug;22(8):1063-79.

Sasikumar, J. M., Maheshu, V., Smilin, A. G., Gincy, M. M. and Joji, C. (2012).“Antioxidant and antihemolytic activities of common Nilgiri barberry (Berberis tinctoria Lesch.) from south India”. International Food Research Journal, 19 (4), 1601- 1607.

Silva Pinto, M., Lajolo, F. M., & Genovese, M. I. (2008). Bioactive compounds and quantification of total ellagic acid in strawberries (Fragaria x ananassa Duch.). Food Chemistry, 107(4), 1629-1635.

Skrovankova, S., Sumczynski, D., Mlcek, J, Jurikova, T., Sochor, J. (2015). Bioactive Compounds and Antioxidant Activity in Different Types of Berries. Int. J. Mol. Sci. 2015, 16, 24673-24706; doi:10.3390/ijms161024673.

Skupien K., Oszmianski J. (2004): Comparison of six cultivars of strawberries (Fragaria × ananassa Duch.)grown in northwest Poland. European Food Research and Technology, 219: 66–70.

Sood, P., Modgil R., Sood., M. (2010). Physico-chemical and nutitional evalaluation of indigenous wild fruit kasmal berberis lycium royle . Indian journal of natural products and resources. Vom 1(3). P. 362-366. 2010

Stoner, G.D., Kresty, L.A., Carlton, P.S., Siglin, J.C. ve Morse, M.A. (1999). Isothiocyanates and freeze-dried strawberries as inhibitors of esophagel cancer. Toxicol Sci. 52, 95-100.

Stevensona, S., and Scalzob, J., (2012). Anthocyanin composition and content of blueberries from

around the world. Journal of Berry Research 2 (2012) 179–189.
Tabart, J., Kevers, C., Evers, D., & Dommes, J. (2011). Ascorbic Acid, Phenolic Acid, Flavonoid and Carotenoid profiles of selected extracts from Ribes nigrum. Journal of Agricultural and Food Chemistry, 59, 4763-70.
Tănase, E.E., Popa, V.I., Popa, M.E., Geicu-Cristea, M., Popescu, P., Drăghici, M. and Miteluț, A.C. (2016), Identification of the most relevant quality parameters for berries - a review, Scientific Bulletin. Series F. Biotechnologies, Vol. XX, pp. 222-233.
Tamer C E (2012). A research on raspberry and blackberry marmalades produced from different cultivars. Journal of Food Processing and Preservation 36: 74-80
Tosun, İ., ve Artık, N., 1998. Böğürtlenin (Rubus L.) Kimyasal Bileşimi Üzerine Araştırma. Gıda. 23 (6):403-413.
Tosun, I. and Yüksek, S. (2003). Antioxidant capacity of small fruits, Gıda, 28(3), 305-311.
Tosun, M. , Ercisli, S., Karlidag, H., and Sengul. M. (2009). Characterization of Red Raspberry (Rubus idaeus L.) Genotypes for Their Physicochemical Properties. Journal Of Food Sci. Vol. 74, Nr. 7.
Tumbas VT, Canadanovic-Brunet JM, Cetojevic-Simin DD, Cetkovic GS, Ethilas SM, Gille L (2012). Effect of rosehip (Rosa canina L.) phytochemicals on stable free radicals and human cancer cells. Journal of the Science of Food and Agriculture 92:1273-1281.
Türkben, C.; Uyla¸ser, V.; ˙Incedayı, B.; Çelikkol, I., (2010). Effects of different maturity periods and processes on nutritional components of rose hip (Rosa canina L.). J. Food Agric. Environ. 2010, 8, 26–3.
Uggla M., Gao X., Werlemark G. Variation among and within dog rose taxa (Rosa sect. caninae) in fruit weight, percentages of fruit flesh and dry matter, and vitamin C content. Acta Agriculturae Scandinavica Section B, Soil and Plant Science 2003; 53: 147-155
Uggla, M., Gustavsson, K.E. (2005). Changes in colour and sugar content in rose hips (Rosa dumalis L. andRosa rubiginosa L.) during ripening. Journal of Horticultural Sciences and Biotechnology, 80(2), 204–208.
Eyduran SP, Ercisli S, Akin M, Beyhan O, Gecer MK, Eyduran E, et al. Organicacids, sugars, vitamin C, antioxidant capacity, and phenolic compounds in fruits of white (Morus alba L.) and black (Morus nigra L.) mulberry genotypes. Journal of Applied Botany and Food Quality. 2015;88:134-8
Vagiri, M. R. (2012). Black currant (Ribes nigrum L.)-an insight into the crop. [http://pub.epsilon.slu.se/8586/7/vagiri_m_120206.pdf].
Villano, D., Fernández-Pachón, M. S., Moyá, M. L., Troncoso, A. M., & GarcíaParrilla, M. C. (2007). Radical scavenging ability of polyphenolic compounds towards DPPH free radical. Talanta, 71(1), 230-235.
Wang S.Y., Lin H.S., (2002. Antioxidant activity in fruits and leaves of blackberry, raspberry, and strawberry varies with cultivar and developmental stage, J. Agric. Food Chem., 2000, 48, 140-146.
Wang, Z.; Cang, T.; Qi, P.; Zhao, X.; Xu, H.; Wang, X.; Zhang, H.; Wang, X. (2015). Dissipation of four fungicides on greenhouse strawberries and an assessment of their risks. Food Control. 55, 215–220
Wang, H., Guo, X., Hu, X., Li, T., Fu, X., Liu, R.H., Comparison of Phytochemical Profiles,Antioxidant and Cellular Antioxidant Activities in Different Varieties of Blueberry (Vaccinium Spp) (2016), Food Chemistry doi: http://dx.doi.org/10.1016/j.foodchem.2016.09.002.
Wang, H., Guo, X., Hu, X., Li, T., Fu, X., & Liu, R. H. (2017). Comparison of phytochemical profiles, antioxidant and cellular antioxidant activities of different varieties of blueberry (Vaccinium spp.). Food Chemistry, 217, 773–781.
Wolfe, K.L. (2008). Cellular antioxidant activity of common fruits. Journal of Agricultural of Food Chemistry, v. 56, p. 8418- 8426, 2008. PMid:18759450.http://dx.doi.org/10.1021/jf801381y7
Xue, H., Aziz, R.M., Sun, N., Cassady, J.M., Kamendulis, L.M. (2001). Inhibition of celluar transformation by berry extracts. Carcinogenesis. 22, 351- 356.
Yildiz, H., Ercisli, S., Hegedus, A., Akbulut, M., Topdas, E.F. (2014). Bioactive content and antioxidant characteristics of wild (Fragaria vesca L.) and cultivated strawberry (Fragaria × ananassa Duch.) fruits from Turkey. . Aliman Journal of Applied Botany and Food Quality 87, 274 - 278
Yilmaz, S.O., and Ercisli, S. (2011). Antibacterial and antioxidant activity of fruits of some rose species from Turkey. Rom. Biotechnol. Lett. 2011, 16, 6407–6411.
Zheng, Y., Wang, S. Y., Wang, C. Y., and Zheng, W. (2007). Changes in strawberryphenolics, anthocyanins, and antioxidant capacity in response to high oxygentreatments .LWT – Food Science and Technology, 40, 49–5
Zia-Ul-Haq, M., Riaz, M., De Feo, V., Hawa Z. E. Jaafar, and Moga, M., (2014). Rubus Fruticosus L.: Constituents, Biological Activities and Health Related Uses. Molecules 2014, 19, 10998-11029.
Zorenc, Z., Veber, R., Stampar, F., Koron, D., Mikulic-Petkovsek, M. (2016). Changes in berry quality of northern highbush blueberry (Vaccinium corymbosum L.) during the harvest season. Turk J Agric For, 40: 855-864.