

Nutritive Value of Strawberry Tree

Subjects: [Food Science & Technology](#)

Contributor: Anica Bebek Markovinović , Irena Brčić Karačonji , Karlo Jurica , Dario Lasić , Martina Skendrović Babojelić , Boris Duralija , Jana Šic Žlabur , Predrag Putnik , Danijela Bursać Kovačević

The strawberry tree (*Arbutus unedo* L.) is a Mediterranean plant known for the traditional use of its fruits and leaves due to their health benefits.

Arbutus unedo L.

agriculture

biological potential

1. Fruits

The components of the nutritional and chemical composition of strawberry tree fruits, through their content and mutual interactions, determine the sensory, nutritional and biological properties of the raw material, as well as the final product. The fruits contain a variety of compounds with excellent nutritional quality, including sugars, unsaturated fatty acids, organic and phenolic acids, fibers, vitamins, proteins and carotenoids ^[1]. Given the basic nutritional and chemical composition, strawberry tree fruits are characterized by a high sugar content, mainly fructose (20–30%), and glucose (about 20%), followed by sucrose (1.5–3%) and maltose (1–2%) ^[2]. The chemical composition of strawberry tree fruits depends on climatic conditions, soil and seasonal harvest ^[2]. Given the specific ripening stages of strawberry tree fruits (not all ripen at the same time), the carbohydrate contents vary greatly. For example, sucrose content may be even lower at the fully ripe stage due to hydrolysis on glucose and fructose during ripening. Because of the high carbohydrate content, the fruits of the strawberry tree also have a high energy value. However, care should be taken when eating them, as the slight fermentation of the fruit can cause digestive problems. In addition to sugar, the fruits are also rich in fiber, both soluble and insoluble, with pectin being the most abundant, which also distinguishes this species from a health point of view.

With regards to mineral composition, strawberry tree fruits are a very good source of potassium, calcium, phosphorus, magnesium and sodium ^{[1][3]}. In addition, the fruits are rich in vitamins, and the high content of vitamins C and E is particularly noteworthy. Some researchers indicate that fresh strawberry tree fruit may contain between 200 and 300 mg 100 g⁻¹ fresh weight (FW) of vitamin C, while vitamin E in unripe fruit may be as high as 1369 mg kg⁻¹ FW ^[4]. In a study conducted in Croatia, the highest vitamin C content was found in wild varieties with 402.41 mg 100 g⁻¹ FW ^[5], which proves that this species can be considered a very good source of vitamin C, even several times higher than certain fruits and vegetables known for their high content of this vitamin, such as citrus fruits, kiwi, peppers, parsley and others. Moreover, fatty acids with a favorable ratio of ω3/ω6-fatty acids have been detected in the fruit, which is due to the linolenic acid, which accounts for 58% of the total percentage of fatty acids ^[2].

Strawberry tree fruits are also characterized by a high content of polyphenolic compounds, including phenolic acids, flavonoids, anthocyanins, catechuic tannins, gallic tannins, coumarins, quinones and anthraquinones, which makes them a plant material with an extremely high antioxidant potential [1][6]. The polyphenolic contents and polyphenolic profiles of strawberry tree fruits differ greatly in different studies, which is primarily a consequence of the specific environmental factors (e.g., climatic conditions) of the particular site where the fruits were collected. For example: El Cadi et al. [7] reported the total polyphenolic contents of fruits collected in northern Morocco ranged from 34.8 to 51.61 mg GAE g⁻¹ dry weight (DW); Ruiz-Rodríguez et al. [8] as 9.51 to 19.73 mg GAE g⁻¹ DW in fruits from Spain; Mendes et al. [9] found an average of 16.7 mg GAE g⁻¹ DW in fruits collected in Portugal; Barros et al. [10] found an average value of 126.83 mg GAE g⁻¹ DW in fruits from the northeastern regions of Portugal; while Colak [11] reported an average value of 557 mg GAE 100 g⁻¹ FW from fruits collected in the eastern region of Turkey. Šic Žlabur et al. [5] studied strawberry tree fruits from different locations on the Croatian Adriatic coast (from northern parts to the southern parts, including the islands) and determined a total phenolic contents ranged from 14.29 (Hvar island) to 18.94 to 18.94 mg GAE g⁻¹ DW (Cres island) [5], proving that not only the location but also the specific microsite has a strong influence on the content of polyphenolic compounds.

In addition to the total phenolic content, the fruits of the strawberry tree are also rich in flavonoids and anthocyanins, as shown by various studies. The total anthocyanin contents varied considerably depending on the analyst or location, but also on the ripening stage of the fruits, with the following values found: from 0.13 to 1.42 mg pelargonidin-3-glucoside g⁻¹ DW [7], 762.6 mg cyanidin-3-glucoside kg⁻¹ DW [12]; from 1.23 to 21.73 mg kg⁻¹ FW [5]. Alarcão-e-Silva et al. [13] found that the total anthocyanin contents in strawberry tree fruits varied according to the ripening stage, with the total anthocyanin content increasing during ripening from 0.25 g kg⁻¹ DW in unripe fruits to 1.01 g kg⁻¹ DW in red fruits (fully ripe).

Among anthocyanins, delphinidin-3-galactoside, cyanidin-3-glucoside, cyanidin-3-arabinoside and cyanidin-3-galactoside were determined [12][14][15]. As described in the literature [14], the most abundant anthocyanin detected in strawberry tree fruits is cyanidin-3-glucoside (average 3.9 mg kg⁻¹ FW), while other authors [15] have managed to distinguish two anthocyanin isomers differing only by the saccharide contained in anthocyanidin, in this case the glucoside and galactoside of cyanidin, and suggested that the most abundant anthocyanin is cyanidin-3-galactoside, with the other isomer containing an average of 28.4 mg kg⁻¹ FW. Similar results were obtained in a study on fruits of wild variety from southern Italy (Pisa region). The most abundant anthocyanins were cyanidin-3-O-glucose, cyanidin-3-O-arabinoside and delphinidin-3-O-galactoside [14].

As mentioned earlier, it is important to emphasize that the polyphenolic profile of individual compounds varies greatly depending on the location and also on the stage of ripeness of the fruit [6]. Accordingly, El Cadi et al. [7] reported values for total flavonoid contents ranging from 37.43 to 41.51 mg quercetin g⁻¹ DW, Barros et al. [10] reported an average value of 34.99 mg g⁻¹ extract, while Šic Žlabur et al. [5] found values ranging from 7 to 15.58 mg catechin g⁻¹ DW. Regarding the phenolic acids, quinic, protocatechuic, gallic, caffeic, ferulic, cinnamic, ellagic, syringic, hydroxycoumarin and vanillic acids were strongly represented [7][16][17]. Considering the flavones, dihydroxyflavone is the most abundant [7]; of the flavan-3-ols, catechins, epicatechins, procyanidin dimer with corresponding gallate and prodelphinidin; and of the flavonols, the hexoside of isorhamnetin, myricetin, quercetin,

kaempferol and apigenin are the most abundant [7]. As suggested by some studies [16], the most abundant compound from the group of polyphenols detected in the fruits of strawberry tree collected in Turkey was gallic acid, followed by gentisic, protocatechuic, *p*-hydroxybenzoic, vanillic and *m*-anisic acids. Different authors from Spain [18] quantified the main important polyphenols (mg 100 g⁻¹ DW) as follows: catechins (313.4); hydroxybenzoic acids (112.2); hydroxycinnamic acids (1.0); flavonols (3.6); ellagic acid (6.9); anthocyanins (5.8); and procyanidins (474.1).

Differences were also found in other polyphenols, for example, in flavonol content between fruits collected in Portugal and Spain. Myricetin-3-*O*-xyloside and quercetin-3-*O*-xyloside were not detected in fruits from Portugal, whereas this was the case in Spanish samples, while quercetin-3-*O*-rutinoside and quercetin-3-*O*-rhamnoside were present in both Portuguese and Spanish wild samples. Moreover, in wild fruits from northeastern Portugal, the main phenolic compounds were flavan-3-ols and galloyl derivatives (60.93 mg 100 g⁻¹), followed by anthocyanins (13.77 mg 100 g⁻¹) and flavonols (10.86 mg 100 g⁻¹) [19]. Within the group of flavan-3-ols and galloyl derivatives, in a study conducted in Spain Pallauf et al. indicated gallocatechin, gallocatechin-4,8-catechin, the proanthocyanidin dimers and epicatechin as the most abundant [15].

The identification of volatile compounds in the fruits of the strawberry tree led to the determination of 41 compounds, which are divided into several subclasses: alcohols are the most abundant volatile compounds; followed by aldehydes and esters. It should be noted that the contents of the listed compounds decrease sharply during ripening. Norisoprenoid derivatives, sesquiterpenes and monoterpenes are other volatile compounds found in strawberry tree fruit, but in very small amounts. The amount of these compounds also varies greatly with the progress of fruit ripening. The content of monoterpenes decreases from unripe to mid-ripe and is highest at the ripe stage. The content of sesquiterpenes increases from unripe to mid-ripeness, after which it is lower. The content of norisoprenoid derivatives decreases with ripeness, which also confirms the fact that the content of volatile compounds strongly depends on the ripening stage of strawberry tree fruit [17].

2. Leaves

In addition to the fruit, the leaf of the strawberry tree is also an important raw material for both nutritional and medicinal purposes. Strawberry tree leaves have a high dry matter content (51–92%), total acidity ranging from 0.7–1.9%, higher acidity, and pH ranging from 3.89 to 5.35, which depends on the location and climate [5]. They also contain various types of phytochemical compounds such as phenolic compounds, vitamins, terpenoids and essential oils [17]. In general, according to the numerous studies conducted, the leaves of the strawberry tree contain a significantly higher content of polyphenolic compounds than the fruits, so the leaf can be considered as a valuable material, especially in terms of human health. Oliveira et al. [20] determined the total phenolic content of strawberry tree leaf extract to average 192.66 mg GAE g⁻¹; Mendes et al. [9] reported values of total phenolic content in leaves to average 170.3 mg GAE g⁻¹; Bouyahya et al. [21] obtained results for total phenolic content ranging from 94.51 and 141.726 mg GAE mg g⁻¹ extract depending on the solvent type; Šic Žlabur et al. [5] between 18.69 and 26.94 mg GAE g⁻¹ FW; Martins et al. [22] reported values for total phenolic content between 254.96 and 495.24 mg g⁻¹ leaf FW; and Brčić Karačonji et al. between 67.07 and 104.74 mg GAE g⁻¹ DW [23].

Regarding polyphenols, here several compounds have been determined, such as: tannins; flavonoids (catechin gallate, myricetin, rutin, afzelin, juglanin, avicularin); phenolic glycosides (quercitrin, isoquercitrin, hyperoside); and iridoid glucosides [24][25][26][27], of which arbutin (62.7 mg 100 g⁻¹ FW), ethyl gallate (44.00 mg 100 g⁻¹ FW) and catechin (54.6 mg 100 g⁻¹ FW) were the most abundant [28]. Hydroquinone, a bioactive metabolite of arbutin, was not detected in any leaf of *A. unedo* [29]. Thanks to advances in analytical techniques, the detailed profiles of leaf phenolics have been established in recent years. Using an ultra-high-performance liquid chromatograph (UHPLC) coupled with a hybrid mass spectrometer-(LTQ OrbiTrap MS), a total of 60 phenols have been identified in the aqueous and methanolic leaf extracts. Flavonoid aglycones (morin, naringenin, myricetin and kaempferol), phenolic acids (protocatechuic acid and chlorogenic acid), and arbutin and its derivatives were detected in leaves, but not in fruits [23]. Using the same technique, Maldini et al. [30] detected 19 phenols in ethanolic leaf extracts from Sardinia. The main phenols detected were flavonoids, mainly quercetin, kaempferol and myricetin derivatives. With a liquid chromatograph coupled with a quadrupole time-of-flight mass spectrometer (LC-QTOF-MS), a total of 37 phytochemicals were detected, and the main constituents in the leaf extracts being phenolic acids, iridoids, proanthocyanidins and flavonoids [31]. The levels of total flavonoids (expressed as % of quercetin) measured in the leaves ranged from 0.52 to 2.14% [32]. In addition, Jurica et al. [32] determined for the first time the total phenolic acid content in the leaf extracts and it was 1.48%, expressed as % of rosemarinic acid.

When observing terpenoids, amyriin acetate, betulinic acid and lupeol were strongly represented in the leaves [10]. Among vitamins, α -tocopherol and vitamin C stand out as highly contained. Further, authors from Croatia determined that the vitamin C contents in the leaves of wild strawberry trees collected from different locations on the Adriatic coast ranged from 61.61 to even 333.83 mg 100 g⁻¹ FW [5].

Among the macroelements in the leaves of *A. unedo*, potassium (1743 mg 100 g⁻¹ DW) and calcium (1299 mg 100 g⁻¹ DW) were the most abundant, while iron (26.8 mg 100 g⁻¹ DW) was the most abundant of the microelements [33], which was similar to the mineral profile in the fruits. According to Asmaa et al. [33] the most abundant volatiles in *A. unedo* leaves were: camphor (43.5%); α -fenchone (17.5%); bornyl acetate (16.0%); eucarvone (3.16%); and myrtenyl acetate (3.16%). Kivack et al. [34] reported that (E)-2-decenal (12.0%); α -terpineol (8.8%); hexadecanoic acid (5.1%); and (E)-2-undecenal (4.8%) were the most abundant. These compositional differences may be the result of differences in cultivation area or extraction procedure [35]. Among the fatty acids, according to Koukos et al. [36], linolenic acid was the most abundant (44.2%), followed by palmitic acid (25.5%) and linoleic acid (7.9%), while according to Dib et al. [37], palmitic acid was the most abundant (38.5%), followed by oleic acid (10.6%), linolenic acid (9.3%) and linoleic fatty acid (5.5%).

Total carotenoid contents ranged from 0.06 to 0.27 mg g⁻¹, and chlorophyll concentrations from 0.19 to 2.37 mg g⁻¹, again which could be correlated with the climate and geolocation [5]. According to Kachoul et al. [38] the anthocyanin contents in strawberry tree leaves ranged from 0.33 to 0.8 mg of cyanidin-3-glucoside per gram of extract, depending on the type of solvent and the extraction procedure.

Since the fruits and leaves of the strawberry tree are a rich source of nutrients and bioactive compounds (**Table 1**) attributed with various biological activities, they represent a perspective raw material to be considered for the

development and formulation of functional foods and nutraceuticals.

Table 1. Individual bioactive compounds found in *A. unedo* fruits and leaves.

Plant Source	Analytics	Bioactive Compound	Concentration	References
Fruit	HPLC	Gallic acid	4.56–36.93 mg 100 g ⁻¹ DW	[39]
		Protocatechuic	1.84–5.90 mg 100 g ⁻¹ DW	
		Gallocatechin	16.15–65.31 mg 100 g ⁻¹ DW	
		Catechin	22.09–49.36 mg 100 g ⁻¹ DW	
		Chlorogenic acid	5.55–27.42 mg 100 g ⁻¹ DW	
		Syringic acid	4.27–7.94 mg 100 g ⁻¹ DW	
		Ellagic acid	8.42–33.73 mg 100 g ⁻¹ DW	
		Quercetin-3-xyloside	1.43–4.09 mg 100 g ⁻¹ DW	
		Rutin	0.90–1.26 mg 100 g ⁻¹ DW	
		Quercetin-3-galactoside	1.66–3.46 mg 100 g ⁻¹ DW	
		Quercetin-3-glucoside	2.11–2.89 mg 100 g ⁻¹ DW	
		Cyanidin-3-glucoside	0.43–7.21 mg 100 g ⁻¹ DW	
		Cyanidin-3-arabinoside	0.36–1.64 mg 100 g ⁻¹ DW	
Fruit	HPLC-TQ-MS/MS	4-hydroxybenzoic acid	0.34–0.50 mg 100 g ⁻¹ DW	[40]
		Gallic acid	1.4–4.7 mg 100 g ⁻¹ DW	

Plant Source	Analytics	Bioactive Compound	Concentration	References
		Syringic acid	0.63 mg 100 g ⁻¹ DW	
		Chlorogenic acid	0.676 mg 100 g ⁻¹ DW	
		Quercetin	0.79–0.84 mg 100 g ⁻¹ DW	
		Quercetin 3-β-glucoside	1.7–2.6 mg 100 g ⁻¹ DW	
		Rutin	0.43–0.57 mg 100 g ⁻¹ DW	
		Kaempferol	0.39–0.74 mg 100 g ⁻¹ DW	
		Catequin	28–149 mg 100 g ⁻¹ DW	
		Epigallocatechin	10–26 mg 100 g ⁻¹ DW	
		Naringin	0.35 mg 100 g ⁻¹ DW	
Fruit	MS/MS	Arbutin	NQ	[30]
		Myricetin pentoside	NQ	
		Myricetin rhamnoside	NQ	
		Kaempferol-rhamnoside (afzelin)	NQ	
Fruit	HPLC	Protocatechuic acid	0.11–0.61 mg 100 g ⁻¹ FW	[41]
		Vanillic acid	0.10–1.17 mg 100 g ⁻¹ FW	
		Ellagic acid	1.11–2.13 mg 100 g ⁻¹ FW	
		Rutin	0.15–0.95 mg 100 g ⁻¹ FW	
		Quercetin	0.12–0.31 mg 100 g ⁻¹ FW	
		Gallic acid	1.62–7.29 mg 100 g ⁻¹ FW	

Plant Source	Analytics	Bioactive Compound	Concentration	References
		Catechin	1.16–5.75 mg 100 g ⁻¹ FW	
Leaves	UHPLC-LTQ Orbitrap MS	Gallocatechin	64.21–211.60 mg kg ⁻¹ DW	[23]
		Protocatechuic acid	1.27–2.47 mg kg ⁻¹ DW	
		Aesculin	1.95–5.88 mg kg ⁻¹ DW	
		Chlorogenic acid	ND–1.95 mg kg ⁻¹ DW	
		Catechin	47.73–102.95 mg kg ⁻¹ DW	
		<i>p</i> -Hydroxybenzoic acid	16.21–27.08 mg kg ⁻¹ DW	
		Caffeic acid	2.61–5.75 mg kg ⁻¹ DW	
		Syringic acid	0.66–2.67 mg kg ⁻¹ DW	
		Vanillic acid	3.71–7.96 mg kg ⁻¹ DW	
		Rutin	29.93–106.03 mg kg ⁻¹ DW	
		<i>p</i> -Hydroxyphenylacetic acid	4.35–6.57 mg kg ⁻¹ DW	
		Hyperoside	635.10–1512.94 mg kg ⁻¹ DW	
		<i>p</i> -Coumaric acid	10.11–32.83 mg kg ⁻¹ DW	
		Catechin gallate	34.48–73.70 mg kg ⁻¹ DW	
		Ferulic acid	2.55–4.85 mg kg ⁻¹ DW	
		Myricetin	ND–1.78 mg kg ⁻¹ DW	
		Quercetin	41.28–124.91 mg kg ⁻¹ DW	
		Naringenin	ND–4.39 mg kg ⁻¹ DW	
		Kaempferol	10.63–35.50 mg	

Plant Source	Analytics	Bioactive Compound	Concentration kg ⁻¹ DW	References
Leaves	HPTLC	Quercitrin	1.21–2.20 mg g ⁻¹ DW	[42]
		Isoquercitrin	ND–0.33 mg g ⁻¹ DW	
		Hyperoside	ND–0.35 mg g ⁻¹ DW	
		Chlorogenic acid	0.61–1.46 mg g ⁻¹ DW	
Leaves	HPLC-PDA	Chlorogenic acid	0.8–6.5 mg g ⁻¹ DW	[43]
		Caffeic acid	0.6–1.0 mg g ⁻¹ DW	
		<i>p</i> -Coumaric acid	0.2–6.6 mg g ⁻¹ DW	
		Quercetin	0.5–10.7 mg g ⁻¹ DW	
Leaves	GC-MS	Arbutin	2.75–6.82 mg g ⁻¹ DW	[44]
Leaves	HPLC-PDA	Arbutin	12.1 mg g ⁻¹ DW	[45]

properties. *Molecules* 2014, 19, 15799–15823.

- El Cadi, H.; El Cadi, A.; Kounnoun, A.; Oulad El Majdoub, Y.; Palma Lovillo, M.; Brigui, J.; Dugo, U.H.P.; Monteiro, J.; Casciola, F. Wild strawberry (*Arbutus unedo*) phytochemicals: Screening and antioxidant activity. *Drying* 2019, 1, 1–10.
- Mendes, L.; de Freitas, V.; Baptista, P.; Carvalho, M. Comparative antihemolytic and radical scavenging activities of strawberry tree (*Arbutus unedo* L.) leaf and fruit. *Food Chem. Toxicol.* 2011, 49, 2285–2291.
- Barros, L.; Carvalho, A.M.; Sá Morais, J.; Ferreira, I.C.F.R. Strawberry-tree, blackthorn and rose fruits: Detailed characterization in nutrients and phytochemicals with antioxidant properties. *Food Chem.* 2010, 120, 247–254.
- Colak, A.M. Morphological and biochemical diversity in fruits of *Arbutus unedo* L. from east aegean region in Turkey. *Erwerbs-Obstbau* 2019, 61, 379–383.
- Fortalezas, S.; Tavares, L.; Pimpão, R.; Tyagi, M.; Pontes, V.; Alves, P.; McDougall, G.; Stewart, D.; Ferreira, R.; Santos, C. Antioxidant properties and neuroprotective capacity of strawberry tree fruit (*Arbutus unedo*). *Nutrients* 2010, 2, 214–229.

12. Alarcão-E-Silva, M.L.C.M.M.; Leitão, A.E.B.; Azinheira, H.G.; Leitão, M.C.A. The Arbutus berry: Studies on its color and chemical characteristics at two mature stages. *J. Food Compos. Anal.* 2001, 14, 27–35.
13. Pawlowska, A.M.; De Leo, M.; Braca, A. Phenolics of *Arbutus unedo* L. (Ericaceae) Fruits: Identification of anthocyanins and gallic acid derivatives. *J. Agric. Food Chem.* 2006, 54, 10234–10238.
14. Pallauf, K.; Rivas-Gonzalo, J.C.; del Castillo, M.D.; Cano, M.P.; de Pascual-Teresa, S. Characterization of the antioxidant composition of strawberry tree (*Arbutus unedo* L.) fruits. *J. Food Compos. Anal.* 2008, 21, 273–281.
15. Ayaz, F.A.; Kucukislamoglu, M.; Reunanen, M. Sugar, non-volatile and phenolic acids composition of strawberry tree (*Arbutus unedo* L. var. *ellipsoidea*) fruits. *J. Food Compos. Anal.* 2000, 13, 171–177.
16. Oliveira, I.; Baptista, P.; Bento, A.; Pereira, J.A. *Arbutus unedo* L. and its benefits on human health. *J. Food Nutr. Res.* 2011, 50, 73–85.
17. Ganhão, R.; Estévez, M.; Kylli, P.; Heinonen, M.; Morcuende, D. Characterization of selected wild mediterranean fruits and comparative efficacy as inhibitors of oxidative reactions in emulsified raw pork burger patties. *J. Agric. Food Chem.* 2010, 58, 8854–8861.
18. Guimarães, R.; Barros, L.; Dueñas, M.; Carvalho, A.M.; Queiroz, M.J.R.P.; Santos-Buelga, C.; Ferreira, I.C.F.R. Characterisation of phenolic compounds in wild fruits from Northeastern Portugal. *Food Chem.* 2013, 141, 3721–3730.
19. Oliveira, I.; Coelho, V.; Baltasar, R.; Pereira, J.A.; Baptista, P. Scavenging capacity of strawberry tree (*Arbutus unedo* L.) leaves on free radicals. *Food Chem. Toxicol.* 2009, 47, 1507–1511.
20. Bouyahya, A.; Moussaoui, N.; Abrini, J.; Bakri, Y.; Dakka, N. Determination of phenolic contents, antioxidant and antibacterial activities of strawberry tree (*Arbutus unedo* L.) leaf extracts. *Br. Biotechnol. J.* 2016, 14, 1–10.
21. Martins, J.; Batista, T.; Pinto, G.; Canhoto, J. Seasonal variation of phenolic compounds in Strawberry tree (*Arbutus unedo* L.) leaves and inhibitory potential on *Phytophthora cinnamomi*. *Trees* 2021, 35, 1571–1586.
22. Brčić Karačonji, I.; Jurica, K.; Gašić, U.; Dramićanin, A.; Tešić, Ž.; Milojković Opsenica, D. Comparative study on the phenolic fingerprint and antioxidant activity of strawberry tree (*Arbutus unedo* L.) leaves and fruits. *Plants* 2022, 11, 25.
23. Carcache-Blanco, E.J.; Cuendet, M.; Park, E.J.; Su, B.-N.; Rivero-Cruz, J.F.; Farnsworth, N.R.; Pezzuto, J.M.; Douglas Kinghorn, A. Potential cancer chemopreventive agents from *Arbutus unedo*. *Nat. Prod. Res.* 2006, 20, 327–334.

24. Legssyer, A.; Ziyyat, A.; Mekh, H.; Bnouham, M.; Herrenknecht, C.; Roumy, V.; Fourneau, C.; Laurens, A.; Hoerter, J.; Fischmeister, R. Tannins and catechin gallate mediate the vasorelaxant effect of *Arbutus unedo* on the rat isolated aorta. *Phytother. Res.* 2004, 18, 889–894.
25. Males, Z.; Plazibat, M.; Vundac, V.B.; Zuntar, I. Qualitative and quantitative analysis of flavonoids of the strawberry tree–*Arbutus unedo* L. (Ericaceae). *Acta Pharm.* 2006, 56, 245–250.
26. Sanjust, E.; Mocci, G.; Zucca, P.; Rescigno, A. Mediterranean shrubs as potential antioxidant sources. *Nat. Prod. Res.* 2008, 22, 689–708.
27. Fiorentino, A.; Castaldi, S.; D’Abrosca, B.; Natale, A.; Carfora, A.; Messere, A.; Monaco, P. Polyphenols from the hydroalcoholic extract of *Arbutus unedo* living in a monospecific Mediterranean woodland. *Biochem. Syst. Ecol.* 2007, 35, 809–811.
28. de Falco, B.; Grauso, L.; Fiore, A.; Bonanomi, G.; Lanzotti, V. Metabolomics and chemometrics of seven aromatic plants: Carob, eucalyptus, laurel, mint, myrtle, rosemary and strawberry tree. *Phytochem. Anal.* 2022, 33, 696–709.
29. Maldini, M.; D’Urso, G.; Pagliuca, G.; Petretto, G.L.; Foddai, M.; Gallo, F.R.; Multari, G.; Caruso, D.; Montoro, P.; Pintore, G. HPTLC-PCA complementary to HRMS-PCA in the case study of *Arbutus unedo* antioxidant phenolic profiling. *Foods* 2019, 8, 294.
30. Tenuta, M.C.; Deguin, B.; Loizzo, M.R.; Dugay, A.; Acquaviva, R.; Malfa, G.A.; Bonesi, M.; Bouzidi, C.; Tundis, R. Contribution of flavonoids and iridoids to the hypoglycaemic, antioxidant, and nitric oxide (NO) inhibitory activities of *Arbutus unedo* L. *Antioxidants* 2020, 9, 184.
31. Jurica, K.; Gobin, I.; Kremer, D.; Čepo, D.V.; Grubešić, R.J.; Karačonji, I.B.; Kosalec, I. Arbutin and its metabolite hydroquinone as the main factors in the antimicrobial effect of strawberry tree (*Arbutus unedo* L.) leaves. *J. Herb. Med.* 2017, 8, 17–23.
32. Asmaa, N.; Abdelaziz, G.; Boulanouar, B.; Carbonell-Barrachina, A.; Cano-Lamadrid, M.; Noguera-Artiaga, L. Chemical composition, antioxidant activity and mineral content of *Arbutus unedo* (leaves and fruits). *J. Microbiol. Biotechnol. Food Sci.* 2019, 8, 1335–1339.
33. Kivcak, B.; Mert, T.; Demirci, B.; Baser, K.H.C. Composition of the essential oil of *Arbutus unedo* L. *Chem. Nat. Compd.* 2001, 37, 445–446.
34. Berka-Zougali, B.; Hassani, A.; Besombes, C.; Allaf, K. Extraction of essential oils from Algerian myrtle leaves using instant controlled pressure drop technology. *J. Chromatogr. A* 2010, 1217, 6134–6142.
35. Koukos, D.; Meletiou-Christou, M.-S.; Rhizopoulou, S. Leaf surface wettability and fatty acid composition of *Arbutus unedo* and *Arbutus andrachne* grown under ambient conditions in a natural macchia. *Acta Bot. Gall.* 2015, 162, 225–232.

36. Dib, M.A.; Paolini, J.; Bendahou, M.; Varesi, L.; Allali, H.; Desjobert, J.-M.; Tabti, B.; Costa, J. Chemical composition of fatty acid and unsaponifiable fractions of leaves, stems and roots of *Arbutus unedo* and in vitro antimicrobial activity of unsaponifiable extracts. *Nat. Prod. Commun.* 2010, 5, 721.
37. Kachkoul, R.; Squalli Housseini, T.; Mohim, M.; El Habbani, R.; Miyah, Y.; Lahrichi, A. Chemical compounds as well as antioxidant and litholytic activities of *Arbutus unedo* L. leaves against calcium oxalate stones. *J. Integr. Med.* 2019, 17, 430–437.
38. Zitouni, H.; Hssaini, L.H.; Ouaabou, R.; Viuda-Martos, M.; Hernandez, F.; Ercisli, S.; Hachimi, H.; Zerhoune, M.; Hanine, H. Functionnal and technological properties of five strawberry (*Arbutus unedo* L.) fruit as bioactive ingredients in functional foods. *Int. J. Food Prop.* 2021, 24, 380–399.
39. Izcara, S.; Morante-Zarzero, S.; Casado, N.; Sierra, I. Study of the phenolic compound profile of *Arbutus unedo* L. fruits at different ripening stages by HPLC-TQ-MS/MS. *Appl. Sci.* 2021, 11, 11616.
40. Gündoğdu, M.; Ercisli, S.; Canan, I.; Orman, E.; Sameeullah, M.; Naeem, M.; Ben Ayed, R. Diversity in phenolic compounds, biochemical and pomological characteristics of *Arbutus unedo* fruits. *Folia Hortic.* 2018, 30, 139–146.
41. Maleš, Ž.; Šarić, D.; Bojić, M. Quantitative determination of flavonoids and chlorogenic acid in the leaves of *Arbutus unedo* L. using thin layer chromatography. *J. Anal. Methods Chem.* 2013, 2013, 385473.
42. Maleš, Ž.; Fabijančić, P.; Barman, A.; Gregov, I.; Bojić, M. Antioksidacijski učinak i HPLC analiza listova planike-*Arbutus unedo* L. *Farm. Glas.* 2015, 71, 523–528.
43. Jurica, K.; Karačonji, I.B.; Šegan, S.; Opsenica, D.M.; Kremer, D. Quantitative analysis of arbutin and hydroquinone in strawberry tree (*Arbutus unedo* L., Ericaceae) leaves by gas chromatography-mass spectrometry/Kvantitativna analiza arbutina i hidrokinona u listovima obične planike (*Arbutus unedo* L., Ericaceae) plinskokromatografskom metodom uz detekciju masenim spektrometrom. *Arch. Ind. Hyg. Toxicol.* 2015, 66, 197–202.
44. Pavlović, R.D.; Lakušić, B.; Došlov-Kokoruš, Z.; Kovačević, N. Arbutin content and antioxidant activity of some Ericaceae species. *Die Pharm. Int. J. Pharm. Sci.* 2009, 64, 656–659.

Retrieved from <https://encyclopedia.pub/entry/history/show/127490>