Anadolu Orman Araştırmaları Dergisi
Anatolian Journal of Forest Research

http://dergipark.org.tr/ajfr

ANATOLIAN JOURNAL OF FOREST RESEARCH

Vaccinium arctostaphylos as a natural antioxidant source: Phenolic content and reducing power activity of fruit water extract

Özlem Aydın Berktaş [1]*

[1]Giresun University Health Services Vocational School, Database, Network Design and Management Department, Telehealth Technician Program, 28100, Giresun, Türkiye

ARTICLE INFO
Received: 23/02/2026
Accepted: 04/07/2026
https://doi.org/10.53516/ajfr.1895735
*Corresponding author:
ozlem.berktas@giresun.edu.tr

ABSTRACT **Research Article**

Background and aims This study aimed to determine the total antioxidant activity (TAC), total phenolic content (TPC), and reducing power capacity (RP) of water extracts obtained from *Vaccinium arctostaphylos* fruits grown in the Eastern Black Sea Region. *Vaccinium arctostaphylos* is a medicinally important plant with various beneficial properties for health. Its richness in phenolic compounds, natural origin, safety profile, and increasing interest as a functional food source have led to significant attention in scientific studies.
Methods Measurements were performed on water extracts adjusted to doses of 1, 2.5, and 5 mg/ml. Total antioxidant activity, phenolic content, and reducing power were determined according to the specified methods.
Results Peroxide formation was significantly inhibited at all three doses of the fruit. Inhibition rates were 38.8%, 55.2%, and 54.1% for the doses, respectively, while ascorbic acid and Trolox inhibited by 49.3% and 79.1%, respectively. Similarly, the amount of phenolic compounds also increased proportionally with dosage (0.79, 1.11, and 1.52 mgGAE/g). Again, the reducing capacities (0.24, 0.34, and 0.46) increased proportionally with dosage.
Conclusions In line with the current findings, it has been determined that *Vaccinium arctostaphylos* fruit has antioxidant properties in a dose-dependent manner.

Key Words: *Caucasian whortleberry*, total antioxidant activity, reducing power, phenolic content

Doğal antioksidan kaynağı olarak *Vaccinium arctostaphylos*: Meyve suyu ekstraktının fenolik içeriği ve indirgeyici güç aktivitesi

ÖZ

Amaç ve Hedefler Bu çalışmada, Doğu Karadeniz Bölgesi'nde yetişen *Vaccinium arctostaphylos* meyvelerinden elde edilen su özütlerinin toplam antioksidan aktivitesi (TAC), toplam fenolik içeriği (TPC) ve indirgeyici güç kapasitesinin (RP) belirlenmesi amaçlanmıştır. *Vaccinium arctostaphylos*, sağlık açısından çeşitli faydalı özelliklere sahip, tıbbi açıdan önemli bir bitkidir. Fenolik bileşikler açısından zenginliği, doğal kökeni, güvenlik profili ve fonksiyonel bir gıda kaynağı olarak artan ilgisi nedeniyle bilimsel çalışmalarda önemli bir ilgi görmüştür.
Yöntemler Ölçümler, 1, 2,5 ve 5 mg/ml dozlarına ayarlanmış su özütleri üzerinde gerçekleştirilmiştir. Toplam antioksidan aktivite, fenolik içerik ve indirgeme gücü belirlenen metodlara göre uygulanmıştır.
Bulgular Meyvenin her üç dozunda da peroksit oluşumu önemli ölçüde inhibe edilmiştir. İnhibisyon oranları dozlar için sırasıyla %38,8, %55,2 ve %54,1 iken, askorbik asit ve Trolox sırasıyla %49,3 ve %79,1 oranında inhibe etmiştir. Benzer şekilde, fenolik bileşiklerin miktarı da dozajla orantılı olarak artmıştır (0,79, 1,11 ve 1,52 mgGAE/g). Yine, indirgeme kapasiteleri (0,24, 0,34 ve 0,46) dozajla orantılı olarak yükselmiştir.
Sonuçlar mevcut bulgular doğrultusunda doza bağlı olarak *Vaccinium arctostaphylos* meyvesinin antioksidan özelliği olduğu tespit edilmiştir.

Anahtar Kelimeler: *Ayı üzümü*, toplam antioksidan aktivite, indirgeyici güç, fenolik içerik

Citing this article:
Aydın Berktaş, Ö., 2026. *Vaccinium arctostaphylos* as a natural antioxidant source: Phenolic content and reducing power activity of fruit water extract. Anatolian Journal of Forest Research, 13, 1895735.

1. Introduction

Medicinal plants contain a variety of bioactive compounds that have long been utilized as alternative therapeutic agents in traditional medical practices. The use of phenolic and flavonoid substance metabolites attracts attention growing scientific interest due to their broad spectrum of biological activities. Numerous studies have shown that these metabolites have significant therapeutic potential, contributing to the treatment or prevention of certain diseases through their antioxidant, anti-inflammatory, antimicrobial, and cytoprotective properties (Fierascu et al., 2021; Barut et al., 2019). In particular, they have been reported to scavenge oxidative stress-triggering radicals, which are the primary factors in the development of these diseases (Tziveleka et al., 2021). Therefore, phenolic compounds and flavonoids are considered important natural antioxidants, particularly in research aimed at preventing and treating various chronic conditions. The fact that these metabolites have little or no side effects also makes them suitable for study purposes. Therefore, the widespread use of natural antioxidants aims to avoid the side effects that synthetic antioxidants can cause (Nirmala et al., 2018). Consequently, research aimed at identifying natural compounds that can prevent cellular damage caused by oxidative stress and the harmful effects of free radicals has gained momentum.

The genus *Vaccinium* L., belonging to the Ericaceae family, exhibits considerable taxonomic diversity worldwide, with approximately 450 species (Ahmadi et al., 2017). Turkey, with its flora rich in medicinal plant potential, is home to many *Vaccinium* species. Extensive studies on the biological activities of *Vaccinium* species are available in the literature, demonstrating the plant's pharmaceutical importance (Papanov et al., 2021; Shamilov et al., 2022). Previous research has revealed that various Vaccinium species possess a broad bioactivity profile, including antioxidant, antimicrobial, and antidiabetic properties (Abidov et al., 2006; Silva et al., 2013; Jurikova et al., 2019).

V. arctostaphylos contains numerous bioactive compounds. These compounds have been purified from the fruit or leaves of the plant using various methods (Lätti et al., 2009). In particular, anthocyanins, polyphenols, and flavonoids have been identified as the most abundant of these compounds (Bighamanganeh et al., 2025; Broñola-Hipol et al., 2024). In addition to these phenolic compounds, the fruit also contains monosaccharides such as fructose, glucose, and sucrose, as well as organic acids such as malic, quinic, and citric acids.

The fruits and leaves of *V. arctostaphylos* are rich in proteins, sugars, dietary fiber, essential minerals such as calcium, magnesium, potassium, and iron, as well as vitamins, all of which contribute to the plant's therapeutic and protective potential (Bighamanganeh et al., 2025; Shamilov et al., 2022). The purpose of using only the water extract of *V. arctostaphylos* fruits in the present study is to be consistent with traditional consumption practices, which often involve aqueous preparations like infusions or decoctions aimed at utilizing the plant's bioactive profile. Water is also the most commonly used solvent for the extraction of phenolic compounds and flavonoids. Therefore, this study was conducted to evaluate the antioxidant capacity, total phenolic content, and reducing power of the aqueous fruit extract of *V. arctostaphylos*, thereby providing a scientific basis for its potential therapeutic applications and supporting future research on this species.

2. Materials and Methods

2.1 Chemicals

All chemicals employed in the experiments were of analytical grade and were sourced from Sigma-Aldrich.

2.2 Preparation of plant fruit and extract

The *V. arctostaphylos* fruits used in this study were obtained from a licensed plant dealer in the Eastern Black Sea Region. To ensure botanical and geographical traceability, the wild fruits were harvested in August and September, at the peak of their ripening period, from natural habitats in the region characterized by a humid subtropical climate and high-altitude mountainous terrain. They are collected from plateaus at an altitude of approximately 1000m-1200m above sea level. After being harvested at the appropriate stage of maturity, the fruits were cleaned and sold in packaged form. The dried fruits were subsequently pulverized by grinding in a mortar with liquid nitrogen. The extraction process was carried out using a Julabo SW22 brand shaking water bath at 40°C-50°C for four days. A total of 100 g of the dried fruit powder was extracted for four days in a shaking water bath using water (500 ml) as the solvent at 50 °C. Following extraction, the solution was filtered and lyophilized to remove all moisture. The antioxidant capacity, reducing power, and phenolic compound content were then analyzed using the fully dried extract samples.

2.3 Determination of antioxidant activity

The antioxidant activity of *V. arctostaphylos* fruit water extract was determined according to the method developed by Mitsuda et al. (1996). The mixture obtained with the appropriate solutions was incubated at 37 °C, and then 0.1 ml of the reaction mixture was vortexed. It was transferred to 75% ethanol and 30% ammonium thiocyanate solutions at 4-h intervals. A 0.02 M $FeCl_2$ solution prepared in 35% HCl was then added. The incubation process was terminated when the absorbance value reached its maximum value (Mitsuda et al., 1996).

2.4 Determination of total phenolic content

The total phenolic content of the fruit samples was determined using the Folin–Ciocalteu method (Singleton et al., 1999). The mixture was incubated according to the literature. Then, 2 ml of Na_2CO_3 was added, and the mixture was incubated again at 30 °C for 90 minutes. After incubation, the absorbance values were expressed as total phenolic content, gallic acid equivalent (GAE) per gram of lyophilized extract.

2.5 Determination of reducing power

The reducing power of *V. arctostaphylos* berries was determined using the method described by Yen and Chen (Yen and Chen, 1995). Water extracts treated with appropriate solutions mentioned in the literature were incubated at 50 °C for

30 minutes. After incubation, an appropriate TCA solution was added and centrifuged. The supernatant obtained was then separated and mixed with 2.5 ml of 0.1% $FeCl_3$ solution and 2.5 ml of water. The absorbance of the mixture was measured at 700 nm. High absorbance values were interpreted as an indicator of high reducing power.

2.6 Statistical analysis

Statistical analyses were conducted using IBM SPSS Statistics version 27. Differences among groups and significance levels were evaluated using one-way ANOVA, and results with a p-value of <0.05 were considered statistically significant.

3. Results

The antioxidant activity of water extracts obtained from *V. arctostaphylos* fruit samples after 60 hours of incubation is shown in Table 1. The results are indicated in the table as inhibition (%). Trolox and ascorbic acid were used as positive controls. As indicated in the table, the three doses of fruit extracts inhibited peroxide formation by 38.8%, 55.2%, and 54.1%, respectively. Ascorbic acid and Trolox also inhibited it by 49.3% and 79.1%, respectively ($p<0.05$) (Table 1 and Figure 1). Based on these statements, it can be said that all three doses of *V. arctostaphylos* fruit samples have antioxidant activity. Similarly, the amount of phenolic compounds also increased proportionally with dosage (0.79, 1.11, and 1.52 mg GAE/g). Again, their reduction capacities (0.24, 0.34, and 0.46) increased proportionally with dosage (Table 1).

Table 1. Total antioxidant activity (TAA), reducing power (RG) and total phenolic compounds (TFB) amounts of water extracts of *Vaccinium arctostaphylos* fruit samples

Samples	Dose (mg/ml)	Total antioxidant activity (TAA)		Reducing power (RP)	Phenolic compound amount (TFB)
		Mean Absorbance (60.hour, 500 nm)	Inhibition (%)	Mean Absorbance (700nm)	(mg GAE/lyophilisate)
Water extract of *V. arctostaphylos* fruit	1	1.64±0.04d	38.8	0.24±0.01a	0.79±0.05a
	2.5	1.20±0.06b	55.2	0.34±0.02b	1.11±0.04b
	5	1.23±0.02b	54.1	0.46±0.03c	1.52±0.05c
Ascorbic acid	1	1.36±0.01c	49.3	-	-
Trolox	1	0.56±0.01a	79.1	-	-
Control	-	2.68±0.04e	-	-	-

Means indicated by different letters in the same column are significantly different according to the Duncan test (P < 0.05).

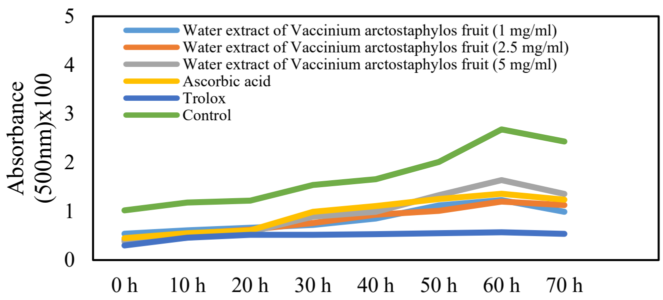

Figure 1. Total antioxidant activity (TAA) amount of *Vaccinium arctostaphylos* water extract

4. Discussion

In this study, the antioxidant capacity, total phenolic content, and reducing power of the water extract obtained from *V. arctostaphylos* fruits were determined. The findings revealed that the plant possesses significant antioxidant potential. The inhibition values observed against linoleic acid peroxidation demonstrated marked efficacy in all doses of the extract compared to the control group. These results are consistent with previous studies on the antioxidant properties of *V. arctostaphylos* (Broñola-Hipol et al., 2024; Bighamanganeh et al., 2025). However, the antioxidant values obtained in this study are relatively lower than those reported in some previous literature. This difference can be attributed to several critical factors. First, solvent selection plays a crucial role; while many previous studies have used organic solvents or hydroalcoholic mixtures (e.g., ethanol or methanol) known for high extraction yields of lipophilic and hydrophilic phenolics, this study relied on a pure water extract to be compatible with conventional consumption. This may have led to a lower extraction efficiency for some hydrophobic bioactive compounds. Second, fruit quality and environmental factors can significantly affect the basic phytochemical profile of wild berries. The positive correlation between total phenolic content and reducing power confirms the fundamental role of phenolic compounds in neutralizing free radicals due to their redox properties. This is also supported by studies reporting that Vaccinium species are rich in phenolic and anthocyanin compounds (Lätti et al., 2009; Ercisli et al., 2012). Studies based on HPLC-MS analyses have revealed that caffeic acid, chlorogenic acid, and various anthocyanins are predominant in *V. arctostaphylos* fruits; these compounds are known for their potent antioxidant activities (Lätti et al., 2009; Antonio et al., 2023). In this study, where only water extract was used as a solvent, the high antioxidant activity indicates that it is rich in hydrophilic phenolic compounds. Some studies have reported high yields with organic solvents such as methanol and ethanol (Tahmaz Karaman, 2021). However, the activity demonstrated with water, which is the most suitable for natural consumption, is quite valuable for the literature. The use of *V. arctostaphylos* as an antidiabetic agent in traditional medicine is supported by studies in the literature that reveal its antioxidant and antidiabetic mechanisms of action (Saliani et al, 2023; Shamilov et al., 2022). Given the important role of oxidative stress in diabetes, the antioxidant capacity of this species, which is rich in phenolic compounds, strengthens the biochemical basis for its traditional use. The dose-response relationship observed in the study is characterized by a marked increase, particularly at a dose of 2.5 mg/ml, but with a more limited additional contribution at a dose of 5 mg/ml. This may be related to the maximum effect of phenolic compounds at certain concentrations or to the analytical method used reaching a certain threshold. Some studies using *Vaccinium* fruit samples have also reported a parallel antioxidant effect (Koca & Karadeniz, 2009; Antonio et al., 2023). The prominence of this plant's phenolic content and antioxidant properties, as well as its anti-inflammatory, antimicrobial, and potential protective effects against many metabolic diseases, have led to its widespread use. This has made it an important species to be evaluated in alternative treatment methods and scientific studies (Shamilov et al., 2022; Martau et al., 2023). However, more comprehensive studies are needed on the bioavailability, toxicological safety, and clinical efficacy of these compounds. Overall, this study demonstrates that *V. arctostaphylos* fruit extract possesses potent antioxidant capacity; that the close correlation between phenolic content and reducing power is the primary source of this biological activity; and that the antioxidant efficacy scientifically supports the plant's traditional uses.

4.1 Study limitations

While the current research provides valuable preliminary information on the traditional use of *V. arctostaphylos* fruits, some limitations must be considered. Firstly, antioxidant capacity was assessed using a single antioxidant assay. Since plant extracts exhibit antioxidant effects through various mechanisms, using multiple complementary assays would provide a more comprehensive profile. There is a lack of detailed phytochemical characterization (e.g., via HPLC or LC-MS/MS) to identify and quantify the specific bioactive compounds responsible for the activities observed in the study. The biological efficacy of the aqueous extract has not been validated using cellular (in vitro) models or in vivo animal studies. Therefore, further research involving advanced phytochemical profiling and biological validation models is needed to fully elucidate the therapeutic potential of *V. arctostaphylos* fruits.

4.2 Conclusion and recommendations

Based on the data obtained, the water extract obtained from *V. arctostaphylos* fruits was found to be an important source of antioxidants and phenolics. Its high phenolic content can be considered an important natural antioxidant species for the treatment of various oxidative stress-related diseases. Therefore, it can guide detailed pharmacological studies for the development of new treatment methods. More comprehensive studies on the bioavailability, toxicological safety, and clinical efficacy of these compounds can be conducted and added to the literature.

References

Abidov, M., Ramazanov, A., Jimenez Del Rio, M., Chkhikvishvili, I. 2006. Effect of Blueberin on fasting glucose, C-reactive protein and plasma aminotransferases in female volunteers with type 2 diabetes: Double-blind, placebo-controlled clinical study. Georgian Medical News, 141, 66–72.

Ahmadi, A., Khalili, M., Mashaee, F., Nahri-Niknafs, B. 2017. The effects of solvent polarity on hypoglycemic and hypolipidemic activities of *Vaccinium arctostaphylos* L. unripe fruits. Pharmaceutical Chemistry Journal, 50(11), 746–752. https://doi.org/10.1007/s11094-017-1524-4.

Barut, B., Barut, E. N., Engin, S., Özel, A., Sezen, F. S. 2019. Investigation of the antioxidant, α-glucosidase inhibitory, anti-inflammatory, and DNA protective properties of *Vaccinium arctostaphylos* L. Turkish Journal of Pharmaceutical Sciences, 16(2), 175–183. https://doi.org/10.4274/tjps.galenos.2018.28247.

Bighamanganeh, H., Salabati, M., Khalilpour, A., Akbaribazm, M., Akbarnezhad, N. 2025. Pharmacological and Therapeutic Properties of the Caucasian Whortleberry (*Vaccinium arctostaphylos* L.): An Overview of the New Findings. Food Science & Nutrition, 13(8), e70702. https://doi.org/ 10.1002/fsn3.70702.

Broñola-Hipol, R. L., Wayas, H. S., Bacuyag, F. M. S., Cabanlong, J. F., Daquigan, M. C., Hipol, R. M. 2024. Phytochemical composition, antioxidant, and antibacterial activities of *Vaccinium barandanum* leaf extract. Journal of ISSAAS, 30(1), 159–174.

Ercisli, S., Tosun, M., Karlidag, H., Dzubur, A., Hadziabulic, S., Aliman, Y. 2012. Color and antioxidant characteristics of some fresh fig (*Ficus carica* L.) genotypes from northeastern Turkey. Plant Foods Hum Nutr, 67, 271–276. https://doi.org/10.1007/s11130-012-0292-2.

Fierascu, R. C., Fierascu, I., Baroi, A. M., Ortan, A. 2021. Selected aspects related to medicinal and aromatic plants as alternative sources of bioactive compounds. International Journal of Molecular Sciences, 22(4), 1521. https://doi.org/10.3390/ijms22041521.

Jurikova, T., Skrovankova, S., Mlcek, J., Balla, S., Snopek, L. 2019. Bioactive compounds, antioxidant activity, and biological effects of European cranberry (*Vaccinium oxycoccos*). Molecules, 24(1), 24. https://doi.org/10.3390/molecules24010024.

Koca, I., Karadeniz, B. 2009. Antioxidant properties of blackberry and blueberry fruits grown in the Black Sea region of Turkey. Scientia Horticulturae, 121(4), 447–450. https://doi.org/10.1016/j.scienta.2009.03.015.

Lätti, A. K., Kainulainen, P. S., Hayirlioglu-Ayaz, S., Ayaz, F. A., Riihinen, K. R. 2009. Characterization of anthocyanins in Caucasian blueberries (*Vaccinium arctostaphylos* L.) native to Turkey. Journal of Agricultural and Food Chemistry, 57(12), 5244–5249. https://doi.org/10.1021/jf9005627.

Martău, G. A., Bernadette-Emőke, T., Odocheanu, R., Soporan, D. A., Bochis, M., Simon, E., Vodnar, D. C. 2023. Vaccinium Species (Ericaceae): Phytochemistry and Biological Properties of Medicinal Plants. Molecules, 28, 1533. https://doi.org/10.3390/molecules28041533.

Mitsuda, H., Yasumoto, K., Iwami, K. 1966. Antioxidative action of indole compounds during the autoxidation of linoleic acid. Eiyo to Shokuryo (Journal of the Japanese Society of Food and Nutrition), 19(3), 210–214. https://doi.org/10.4327/jsnfs1949.19.210.

Nirmala, C., Bisht, M. S., Bajwa, H. K., Santosh, O. 2018. Bamboo: A rich source of natural antioxidants and its applications in the food and pharmaceutical industry. Trends in Food Science and Technology, 77, 91–99. https://doi.org/10.1016/j.tifs.2018.05.003.

Papanov, S. I., Petkova, E. G., Ivanov, I. G. 2021. Polyphenols content and antioxidant activity of bilberry juice obtained from different altitude samples. Journal of Pharmaceutical Research International, 33(29A), 218–223. https://doi.org/10.9734/JPRI/2021/v33i29A31581.

Saliani, N., Montasser Kouhsari, S., Izad, M. 2023. The potential hepatoprotective effect of *Vaccinium arctostaphylos* L. fruit extract in diabetic rat. Cell Journal, 25(10), 717–726. https://doi.org/10.22074/cellj.2023.2004742.1328.

Santos-Rufo, A., Rodríguez-Solana, R., Fernández-Recamales, M. A., Sayago-Gómez, A., Weiland-Ardaiz, C. M. 2024. Comparative analysis of anatomical characteristics and phenolic compounds of two highbush blueberry (*Vaccinium corymbosum* L.) cultivars with different rooting ability of semi-hardwood cuttings. Scientia Horticulturae, 324, 112591. https://doi.org/10.1016/j.scienta.2023.112591.

Shamilov, A. A., Olennikov, D. N., Pozdnyakov, D. I., Bubenchikova, V. N., Garsiya, E. R., Larskii, M. V. 2022. Caucasian blueberry: Comparative study of phenolic compounds and neuroprotective and antioxidant potential of *Vaccinium myrtillus* and *Vaccinium arctostaphylos* leaves. Life, 12(12), 2079. https://doi.org/10.3390/life12122079.

Silva, S., Costa, E. M., Pereira, M. F., Costa, M. R., Pintado, M. E. 2013. Evaluation of the antimicrobial activity of aqueous extracts from dry *Vaccinium corymbosum* extracts upon food microorganism Food Control, 34(2), 645–650. https://doi.org/10.1016/j.foodcont.2013.06.012.

Singleton, V. L., Orthofer, R., Lamuela-Raventós, R. M. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. Methods in Enzymology, 299, 152-178. https://doi.org/10.1016/S0076-6879(99)99017-1.

Tahmaz Karaman, H., Kusku, D. Y., Söylemezoğlu, G. 2021. Phenolic compounds and antioxidant capacities in grape berry skin, seed and stems of six wine grape varieties grown in Turkey. Acta Scientiarum Polonorum Hortorum Cultus, 20(1), 15–25. https://doi.org/10.24326/asphc.2021.1.2.

Tziveleka, L. A., Tammam, M. A., Tzakou, O., Roussis, V., Ioannou, E. 2021. Metabolites with antioxidant activity from marine macroalgae. Antioxidants, 10(9), 1431. https://doi.org/10.3390/antiox10091431.

Yen, G. C., Chen, H. Y. 1995. Antioxidant activity of various tea extracts in relation to their antimutagenicity. Journal of Agricultural and Food Chemistry, 43(1), 27–32. https://doi.org/10.1021/jf00049a007.