MAS Journal of Applied Sciences
Uygulamalı Bilimler Dergisi
ISSN: 2757-5675
masjaps.com

DOI: http://dx.doi.org/10.5281/zenodo.7379762

Derleme Makalesi / Review Article

The Necessities of Cranberry bush (*Viburnum opulus*) Evaluation for Horticultural Cultivation

Murat GÜNEY[1*] (Orcid ID: 0000-0003-2882-8347), Muhammet Ali GÜNDEŞLİ[2] (Orcid ID: 0000-0002-7068-8248)

[1]Yozgat Bozok University, Faculty of Agriculture, Department of Horticulture, Yozgat
[2]Gaziantep University, Department of Plant and Animal Production, Nurdagı Vocational School, Gaziantep

*Sorumlu yazar (Corresponding author): murat.guney@yobu.edu.tr

Geliş Tarihi (Received): 28.10.2022 **Kabul Tarihi (Accepted)**: 27.11.2022

Abstract

The challenges for providing healthy food needs of increasing population growth make it necessary to evaluate new food sources which can be easily found in nature and are a rich source of secondary metabolites. Despite many cultivated horticultural species, Attention to the cultivation of wild species has been neglected. Among these species, the European Cranberry bush (*Viburnum opulus* L.) is a lesser-known horticultural plant that can be considered for taking under cultivation. Recently, the cranberry bush plant has been preferred because of its use as a decorative ornamental plant as well as its unique taste, aroma, and benefits for human nutrition and health. To have economic justification for the cultivation of *V. opulus* fruit, its application in the foods and pharmaceuticals industry should be highlighted. Therefore, it is necessary to know its biochemical components and health-promoting activities. Almost all parts of European cranberry bush plant including Flowers, leaves, and bark have been used in folk medicine since a long time ago to contain large amounts of tannins, carotenoids, isovalerianic acid, saponins, and glycosides. Recently, bioactive compounds extracted from European cranberry bush have been used as raw material for the pharmaceutic industry to cure many diseases especially different types of cancer. This study aims to investigate various aspects of this precious plant to make it economically viable for commercial cultivation on large scale.

Keywords: Cranberry bush, horticulture, cultivation, health, industry

INTRODUCTION

European cranberrybush (*Viburnum opulus* L.,) with other names "snowball tree, guelder-rose, cramp bark" is known as "Gilaburu" in Turkey and is a member of the Elderberry (Adoxaceae) family formerly in Honeysuckle (Caprifoliaceae) family (Velioglu et al., 2006; Cesoniene et al., 2010; Capar et al., 2021; Zarifikhosroshahi et al., 2020). The European cranberrybush is native to Europe, Central Asia, and northern Africa (Cesoniene and Daubaras 2006; Cesoniene et al., 2008), and is locally found as wild populations in the central, western, and northern provinces of Turkey, especially in Anatolia. *V. lantana* L., *V. orientale Pallas and V. tinus* L. are other species of *Viburnum* that are found in Turkey flora (Davis, 1972; Davis, 1988; Baytop, 1999). Although the plant is well known in some provinces of Turkey where the plant is naturally found, it is less known in other provinces. The fruits of European cranberry bush are dark-red and contain high levels of polyphenols, including (+)- catechin, chlorogenic acid, (-)- epicatechin, proanthocyanidin, and quercetin. It is also a rich source of ascorbic acid, malic acid, and oxalic acid and contains (Capar et al., 2021, Zarifikhosroshahi et al., 2018). Due to the astringent taste of fruits, they are not preferred as fresh fruit and are usually consumed as jellies, marmalades, sauces, and beverages. However, the application of fruits as food either as edible products or as culinary ingredients is prevalent. Leaves, flowers and fruits, and barks of *V.opulus* have been used in folk medicine, especially in Turkey. Recently, attention to this plant has increased because it is preferred as a decorative ornamental plant with beautiful flowers as well as useful aspects for human health and nutrition (Ersoy et al., 2017; Akbulut et al., 2018; Zarifikhosroshahi et al., 2020). Free radicals which are produced in the body under normal metabolic conditions or through various external factors play an important role in the formation of many degenerative diseases such as cancer, and cardiovascular and nervous diseases. Although the harmful effects of free radicals are kept under control by natural defense systems in the body such as superoxide dismutase, glutathione peroxidase, catalase, peroxidase, etc, these defense mechanisms should also be supported by natural antioxidant compounds to be taken from the diet (Koca and Karadeniz, 2003). For this purpose, fruit and fruit juices are considered among the main natural antioxidant sources recommended to be included in a healthy diet. The fruits of European cranberry bush have high levels of natural antioxidant compounds besides having compounds with antiviral, antibacterial, and antibiotic properties (Yıldız and Ekici, 2019). Along with the fruit, the seeds of *V. opulus* also have a rich nutrient composition. The seeds of *V. opulus* have a much higher level of total phenolic content resulting in high antioxidant properties than fruit (Cam et al., 2007). The seeds have also been used to fertilize and feed the animals due to their nutritional contents as well as to cure illnesses. However, the application of seeds is predominant in painting as well as in the cosmetic industry (Yunusova et al., 2004), curing illnesses.

The Morphology Of Plant And Breedıng Opportunıtıes

The fruits of European cranberry bush are in a bundle with a cluster of 34-54 dark-red color fruit grains. Due to its beauty during the flowering period, it was called "Gül Ebru" in the Seljuks and Ottomans empires which the name of Gilaburu in Turkey comes from (Iwai et

al., 2004; Fukuyama et al., 2005; Kim et al., 2005; Velioglu et al., 2006; Zayachkivska et al., 2006; Lavigne et al., 2008; Bae et al., 2010; Cesoniene˙ et al., 2010; Kalyoncu et al., 2013; Zarifikhosroshahi, 2015). *V. opulus* is a shrubby, fast-growing, white-flowered plant that can live up to 300 years thanks to its Suckers and starts to yield 3 years after planting (Çam 2005; Hızlısoy 2009). The beautiful flowers and fruits of European cranberry bush stay on the tree in seasons from August to October even maybe in winter and make it to be evaluated as a preferred ornamental plant. The height of the European cranberry bush tree reaches 4 m. It is a multi-stemmed dense shrub but does not form thickets by spreading and form close branching (Yıldız and Ekici, 2019). *V. opulus* prefers soils rich in organic matter and needs plenty of water to grow well and sun to produce well-colored and quality fruit. Therefore, it grows on forest edges and areas where forests are sparse, mostly near water and in damp places (Zarifikhosroshahi, 2015). The leaves are opposite, crisscross with the next, toothed margins, sometimes 3 and sometimes 5 lobed, 3-veined, 5-10 cm long, and broadly shaped. There are some small stalkless glands up to 6 near the base of the leaf on the grooved reddish-green stalk. The groove in the leaf stalk is narrow and v-shaped (Figure 1). In summer the leaves are green but become scarlet in Autumn (Ersoy et al., 2017).

Figure 1. The leaves of *V. opulus* (Anonymous, 2015)

The flowers are creamy-white with and 7 to 10 cm across. Flowering occurs in late May and June. Each bloom is composed of an outer ring of large, showy, and noticeable sterile flowers and an inner ring of tiny fertile ones with smaller florets including the white 5-parted corollas and small, green, 5-pointed lobes calyx. The florets in the reproductive inner ring have 5 stamens with white filaments and creamy-colored anthers. The stamens are spreading and placed alternately to the petals. The plant usually is self-sterile and needs nearby plants for pollination to produce a desirable yield (Figure 2; Kajszczak et al., 2020). The fruit is cluster-shaped and round and has hard seeds. The fruits ripen in September and October, and resemble the true cranberry in size and color but are more translucent when ripe. Although the species has potential for production on large scale for both landscape and its application in the food and pharmaceutic industry, it never developed into a commercial fruit crop (Figure 2; Zarifikhosroshahi, 2015; Akbulut et al., 2018).

Figure 2. The flowers and fruits of *V. opulus* (Anonymous, 2015)

The Bıoactıve Compounds Of *V. Opulus* And Its Applıcatıon In The Pharmaceutıcal Industry

To have economic justification for the cultivation of *V. opulus* fruit, its application in the foods and pharmaceuticals industry should be highlighted. *V. opulus* can be widely used in pharmacology. Therefore, it is necessary to have knowledge about its biochemical components and health-promoting activities. There are several studies on the phytochemical profile of *V. opulus*. The fruits contain organic acids, polyphenolics, flavonoids, and anthocyanins. Fruits and fruit juices are the main natural sources of antioxidants, which are recommended to take place in a healthy diet (Leong and Shui 2002; Garcia-Alonso et al., 2004; Akbulut et al., 2018). Antioxidant properties of fruits come from the high levels of phenolic compounds and can be evaluated as a remedy for health problems (Arena et al., 2001; Netzel et al., 2002; Bermudez-Soto and Thomas-Barberan, 2004). Studies proved that the fruits of *V. opulus* are applied to treat many diseases such as heart disease, coughs and colds, digestive troubles, and bleeding. The fruit juice of European cranberry bush with its unique taste and smell, has diuretic effects, meaning, it dissolves swelling and edema in the body, stimulates the kidneys and helps to remove waste products from the body besides inhibiting the spasms and uterine disease via sedative properties (Yürükür, 1993; Zarifikhosroshahi, 2015; Zarifikhosroshahi et al., 2018; Koparal, 2019). In addition, bioactive compounds in European cranberry bush confer anti-inflammatory properties to it and promote blood glucose uptake in diabetics, improving lipid metabolism. The extracts of dried fruits have also

exhibited antimicrobial properties (Sadic et al., 2006). A cramp is a tissue spasm causing sudden and severe pain following contracts in muscles. A particularly common type of cramp occurs during sleep. The barks of European cranberry bush have prominent antispam features, which is why, *V. opulus* is sometimes called cramp bark in English. Some researchers reported that the extracts of *V. opulus* fruit have antimicrobial activity and may affect human pathogenic bacteria (Sagdic et al. 2006; Cesoniene et al., 2012). Moreover, the bark and leaves of *V. opulus* contains pharmacologically important glycoside compounds such as vibumin, astmalin, a-amyrin and ß-amyrin, oxalates, and paeonoside (Çam, 2005). The results of some research in the United States showed that the consumption of 250 ml of European cranberry bush fruit juice per day has positive effects in reducing some tumors, due to its antioxidant compounds. It also has soothing, vascular width-regulating, skeletal and muscle-relaxing, and heart-strengthening effects (Yao et al., 2004, Wang et al., 2011, Kraujalyte et al., 2012). Due to containing acidic phytochemicals, the fruits of European cranberry bush have the ability to destroy the kidney stone through chemical dissolution. The stone dissolves within the urine without the need for surgery or the laser technique used today (Aksoy et al., 2004). Known as Tchervena Kalinka in Bulgaria and Pallone di Maggio in Italy; In Bulgaria, it is used to stop bleeding and in Italy, it is used to prevent miscarriage (Leporatti and Ivancheva, 2003). The consumption of *V. opulus* relieves migraine and headaches (Milton, 1998). The fruit juices of *V. opulus* are consumed by Turkish people who live in the middle Anatolian region for preventing some stomach and kidney problems. European cranberrybush is commonly used in herbal medicine as a nerve sedative and antispasmodic in asthma and hysteria. Moreover, arabinose and rhamnose sugars in *V. opulus* stimulate the immune system by increasing the lysosomal enzyme secretion and phagocytosis of macrophages in the peritoneum (Aksoy et al., 2004; Çam 2005). However, the high level of vitamin C also strengthens the immune system. Among diseases, cancer is one of the most devastating ones that has affected millions of lives all over the world. Cancer is a genetic disease and is caused by mutations in genes controlling the function of cells (Rop et al., 2010; Khazir et al., 2014). There is a great interest in identifying the potential benefits of *V. opulus* and its extracts to treat different kinds of cancer. In a study, it was proved that the powder extracts of *V. opulus* suppress the proliferation and GSTP1 expression of breast cancer cells (MCF-7 cells), and this suppression is ascribed to both induction of apoptosis and DNA damage and may be appropriate for drug therapy efficacy at the molecular level (Kaan, 2022). In another study, it was shown that the fruit juices of *V. opulus* may prevent colon cancer at the initiation stage (Wu et al., 2020). The seed oil of *V. opulus* exhibit excellent oxidative stability due to the high amount of tocopherols (vitamin E), carotenoids (provitamin A), and unsaturated fatty acids (Grebnava and Nesterova, 2006; Yang et al., 2011). Furthermore, Seed oils have also antimicrobial properties and oxidation stability effects. Because of the nutrient composition of seed oil of *V. opulus* as well as its health benefits such as decreasing blood cholesterol levels, increasing immunity, and making the wall of blood vessels more elastic, recently, it has been receiving increased attention (Rop et al., 2010). Therefore, the seed oil of *Viburnum opulus* is

probably a preferred candidate for application in food industries, pharmaceuticals, and cosmetics in the near future (Capar et al., 2021).

CONCLUSION

European Cranberries contain diverse phytochemicals relevant to human health. There is not enough research on the species *V. opulus* fruit, which is of great importance in terms of human health and nutrition and its importance is increasing day by day both in the food and pharmaceutical industry. On the other hand, ecological changes upset the balance in the cultivation of horticultural plants. The need for the cultivation of plants with high potential for evaluating both healthy food and industry along with an assessment of agricultural waste is of importance for sustainable agriculture. Although cross-breeding programs are needed to eliminate or descend unwanted characteristics and strengthen the desired aspects of fruits, there are limited studies on molecular approaches to identify the true-to-name of accessions despite enough diversity of European cranberry bushes accessions. However, studies on productivity, fruit properties, and nutrient and bioactive components of *V. opulus* accessions leading to the selection of the most valuable clones and cultivars should be increased.

REFERENCES

Akbulut, M., Calisir, S., Marakoglu, T., Coklar, H. 2008. Chemical and technological properties of European cranberrybush (*Viburnum opulus* L.) fruits. Asian Journal of Chemistry, 20(3): 1875.

Arena, E., Fallico, B., Maccarone, E. 2001. Evaluation of antioxidant capacity of blood orange juices as influenced by constituents, concentration process and storage. Food Chemistry, 74: 423-427.

Bae, K., Chong H., Kim D., Choi Y.W., Kim Y.S., Kim Y.K. 2010. Compounds from *Viburnum sargentii* Koehne and evaluation of their cytotoxic effects on human cancer celllines. Molecules, 15(7): 4599-4609.

Baytop, T. (1999). Therapy with medicinal plants in Turkey past and present, 2nd ed. Nobel Tıp Kitabevi, Istanbul.

Bermudez-Soto, M, J., Tomas-Barberan, F. A. 2004. Evaluation of commercial red fruit juice concentrates as ingredients for antioxidant functional juices. Eur. Food. Res. Technol., 219: 133-141.

Cam, M., Hisil, Y., Kuscu, A. 2007. Organic acid, phenolic content, and antioxidant capacity of fruit flesh and seed of *Viburnum opulus*. Chem. Nat. Compd., 43: 460-461.

Capar, T.D., Dedebas, T., Yalcin, H., Ekici, L. 2021. Extraction method affects seed oil yield, composition, and antioxidant properties of European cranberrybush (*Viburnum opulus*). Industrial Crops and Products, 168: 113632.

Cesoniene L., and Daubaras R. 2006. Diversity of yielding capacity and biochemical composition of European cranberry bush (*Viburnum opulus*) genetic resources. Scripta Horti Botanici Universitatis Vytauti Magni, 11: 19-28.

Cesoniene L., Daubaras R., Vencloviene J., Viskelis P. 2010. Biochemical and a gro-biological diversity of *Viburnum opulus* genotypes. Cent. Eur. J. Biol., 6: 864-871.

Cesoniene, L., Daubaras, R., Viskelis, P., Sarkınas, A. 2012. Determination of the total phenolic and anthocyanin contents and antimicrobial activity of *Viburnum opulus* Fruit Juice. Plant Foods Hum Nutr, 67: 256-261.

Cesonienee L., Daubaras R., Viskelis P. 2008. Evaluation of productivity and biochemical components in fruit of different *Viburnum* accessions. Biologia, 54: 93-96.

Çam, M. 2005. Kayseri Bölgesi'nde Tüketilen Gilaburu (*Viburnum opulus*) Meyve Suyunun Organik asit ve Fenolik Bileşiklerinin Yüksek Basınç Sıvı Kromotografisi (HPLC) ile Belirlenmesi. Ege Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi, İzmir.

Davis, P.H. 1972. In: In: Davis, P.H. (Ed.), Flora of Turkey and the East Aegean Islands Vol.3. Edinburgh University Press, Edinburgh, pp. 328-369.

Davis, P.H., Mill, R.R., Tan, K. 1988. Flora of Turkey and the East Aegean Islands 10. Edinburgh University Press, Edinburgh, pp. 154.

Ersoy, N., Ercisli, S., Gundogdu, M. 2017. Evaluation of European Cranberrybush (*Viburnum opulus* L.) genotypes for agro-morphological, biochemical and bioactive characteristics in Turkey. Folia Horticulturae, 29(2): 181-188.

Fukuyama, Y., Minoshima, Y., Kishimoto, Y., Chen, I. S., Takahashi, H., Esumi, T. 2005. Cytotoxic iridoid aldehydes from Taiwanese Viburnum luzonicum. Chemical and Pharmaceutical Bulletin, 53(1): 125-127.

Garcia-Alonso, M., De Pascual-Teresa, S., Santos-Buegla, C, Rivas-Gonzalo, J.C. 2004. Evaluation of the antioxidant properties of fruits. Food Chemistry, 84: 13-18.

Grebnava, E.V., Nesterova, O.V., 2006. Berry marc oils as untraditional plant resourse for functional food and fitopreparation. In: Martirosyan, D.M. (Ed.), Functional Foods for Chronic Diseases. D&A Inc., Texas, pp. 152-157.

Hızlısoy, H. 2009. Çeşitli mikroorganizmalar üzerine gilaburunun antimikrobiyal etkisinin incelenmesi. Erciyes Üniversitesi, Sağlık Bilimleri Enstitüsü, Yüksek Lisans Tezi, Kayseri.

Iwai, K., Onodera, A., & Matsue, H. 2004. Inhibitory effects of *Viburnum dilatatum* Thunb. (gamazumi) on oxidation and hyperglycemia in rats with streptozotocin-induced diabetes. Journal of Agricultural and Food Chemistry, 52(4): 1002-1007.

Kaan, D. 2022. Assessment of cranberry bush on MCF-7 human breast cancer cells. Indian Journal of Biochemistry & Biophysics, 59: 985-997.

Kajszczak, D., Zakłos-Szyda, M., & Podsędek, A. 2020. *Viburnum opulus* L.-A review of phytochemistry and biological effects. Nutrients, 12(11): 3398.

Kalyoncu, I.H., Ersoy, N., Elidemir, A. Y., Karalı, M.E. 2013. Some physico-chemical characteristics and mineral contents of gilaburu (*Viburnum opulus* L.) fruits in Turkey. International Journal of Agricultural and Biosystems Engineering, 7(6): 424-426.

Khazir, J., Mir, B. A., Pilcher, L., Riley, D. L. 2014. Role of plants in anticancer drug discovery. Phytochemistry Letters, 7: 173-181.

Kim, M. Y., Iwai, K., Matsue, H. 2005. Phenolic compositions of *Viburnum dilatatum* Thunb. fruits and their antiradical properties. Journal of Food Composition and Analysis, 18(8): 789-802.

Koca, N., and Karadeniz, F. 2003. Serbest radikal oluşum mekanizmaları ve vücuttaki antioksidan savunma sistemleri. GIda Mühendisliği Dergisi, 6: 32-37.

Koparal, A. T. 2019. *In vitro* evaluation of gilaburu (*Viburnum opulus* L.) juice on different cell lines. Anadolu Journal of Educational Sciences International, 9(2): 549-571.

Kraujalyte, V., Leitner, E., Venskutonis, P.R. 201). Chemical and sensory characterisation of aroma of *Viburnum opulus* fruits by solid phase microextraction-gas chromatography–olfactometry. Food Chemistry, 132(2): 717-723.

Lavigne, J.P., Bourg, G., Combescure, C., Botto, H., Sotto, A. 2008. *In-vitro* and *in-vivo* evidence of dose-dependent decrease of uropathogenic Escherichia coli virulence after consumption of commercial *Vaccinium macrocarpon* (cranberry) capsules. Clinical Microbiology and Infection, 14(4): 350-355.

Leong, L.P., and Shui, G. 2002. An investigation of antioxidant capacity of fruits in Singapore markets. Food Chemistry, 76: 69-75.

Leporatti, M.L., and Ivancheva, S. 2003. Preliminary comparative analysis of medicinal plants used in the traditional medicine of Bulgaria and Italy. Journal of Ethnopharmacology, 87(2-3): 123-142.

Milton, D. 1998. Using alternative and complementary therapies in the emergency setting. Journal of Emergency Nursing, 24(6): 500-508.

Netzel, M., Strass, G., Kaul, C., Bitsch, I., Dietrich, H., and Bitsch, R. 2002. *In vivo* antioxidant capacity of a composite berry juice. Food Research International, 35: 213-216.

Rop, O., Reznicek, V., Valsikova, M., Jurikova, T., Mlcek, J., Kramarova, D. 2010. Antioxidant properties of European cranberry bush fruit (Viburnum opulus var. edule). Molecules, 15: 4467-4477.

Sagdic, O., Aksoy, A., Ozkan, G. 2006. Evaluation of the antibacterial and antioxidant potentials of cranberry (gilaburu, *Viburnum opulus* L.) fruit extract. Acta Alimentaria, 35(4): 487-492.

Anonymous, 2015. Friends of the Wild Flower Garden, Inc. Photos are by G. D. Bebeau unless otherwise credited. Available from: www.friendsofthewildflowergarden.org (Accessed: 23.08.2022).

Velioglu, Y.S., Ekici, L., Poyrazoglu, E.S. 2006. Phenolic composition of European cranberrybush (*Viburnum opulus* L.) berries and astringency removal of its commercial juice. International Journal of Food Science and Technology, 41: 1011-1015.

Wang, S., Melnyk, J.P., Tsao, R., Marcone, M.F. 2011. How natural dietary antioxidants in fruits, vegetables and legumes promote vascular health. Food Research International, 44(1): 14-22.

Aksoy A., Güvensan, A., Akçiçek E.,Öztürk, M., 2004. Etnoecolpgy of *Viburnum opulus* L. International symposium on medicinal plant. Linkages Beyond National Boundarise. September 7-9, Islamabad, Pakistan.

Wu, X., Xue, L., Tata, A., Song, M., Neto, C. C., Xiao, H. 2020. Bioactive components of polyphenol-rich and non-polyphenol-rich cranberry fruit extracts and their chemopreventive effects on colitis-associated colon cancer. Journal of Agricultural and Food Chemistry, 68(25): 6845-6853.

Yang, B., Ahotupa, M., Maatta, P., Kallio, H., 2011. Composition and antioxidative activities of supercritical CO2-extracted oils from seeds and soft parts of northern berries. Food Res. Int., 44: 2009-2017.

Yao, L. H., Jiang, Y. M., Shi, J., Tomas-Barberan, F. A., Datta, N., Singanusong, R., Chen, S. S. 2004. Flavonoids in food and their health benefits. Plant foods for human nutrition, 59(3): 113-122.

Yıldız, R., and Ekici, H. 2019. Gilaburu (*Viburnum opulus* L.)'nun Farmakolojik Açıdan Değerlendirilmesi. Veteriner Farmakoloji ve Toksikoloji Derneği Bülteni, 10(1): 16-23.

Yunusova, S., Karimova, A., Tsyrlina, E., Yunusov, M., Denisenko, O. 2004. Change on storage of biological activity of *Viburnum opulus* seed components. Chem. Nat. Compd., 40: 423-426.

Yürükür, A., 1993. *Viburnum orientalle* pallas üzerinde fitokımiyasal çalışmalar. Hacettepe Üniveristesi, Sağlık Bilimleri Enstitüsü, Doktora Tezi, Ankara.

Zarifikhosrohahi, M., Murathan, Z. T., Kafkas, E., 2018. Pomological Characteristics and Biochemical Composition of Gulder-Rose (*Viburnum opulus* L.) Fruits Growing at Different Locations in Turkey. 1. International Mersin Symposium, Mersin, 01-03 November, Mer Ak Yayınları, 4: 356-365.

Zarifikhosroshahi, M. 2015. Gilaburu (*Viburnum opulus* L.) Meyvelerinde Biyoaktif, Biyokimyasal ve Besin Element İçeriklerinin Belirlenmesi. Çukurova Üniversitesi, Fen Bilimleri Enstitüsü, Biyoteknoloji Anabilim Dalı, Yüksek Lisans Tezi, Adana.

Zarifikhosroshahi, M., Murathan, Z. T., Kafkas, E., Okatan, V. 2020. Variation in volatile and fatty acid contents among *Viburnum opulus* L. fruits growing different locations. Scientia Horticulturae, 264: 109160.

Zayachkivska, O.S., Gzegotsky, M.R., Terletska, O.I., Lutsyk, D.A., Yaschenko, A.M., Dzhura, O.R. 2006. Influence of *Viburnum opulus* proanthocyanins on stres induced gastrointestinal mucosal damage. J. Physiol Pharmacol., 57(5): 155-167.