

Flavonoids and Amino Acids Analysis of the Fruits of *Cornus mas* L. Introduced in Uzbekistan

Gulnaz Matkarimova¹, Nodira Nurullayeva^{2*}, Khislat Khaydarov²

¹Department of Medical Biology and Genetics, Samarkand State Medical University, Samarkand, Uzbekistan

²Department of Botany, Samarkand State University, Samarkand, Uzbekistan

Email: gulnazmatkarimova88@mail.ru, *nodira.nurullayeva90@mail.ru

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Abstract

Cornelian cherry is used in the food and pharmaceutical industry as an ornament, in traditional medicine, and in the manufacture of household items. It is widely used in medicine for the prevention and treatment of many diseases. Therefore, it is important to research the chemical composition of these species. In the article, based on our research, the analysis of the quantitative calculation of flavonoids and amino acids of the fruits of the “Elegant” and “Svetlyachok” cherry varieties was carried out. It was found that the amount of amino acids in the fruits of *Cornus mas* L., introduced in Uzbekistan, is higher in the variety “Svetlyachok” 2.643235 mg/g. In “Elegant” variety it was 1.794235 mg/g. The amount of 4 different flavonoids in the fruit was also determined. It has been established that the Elegant variety has a high concentration of lutein and rutin, and the svetlyachok has a high concentration of apigenin and quercetin.

Keywords

Cornus mas L., Medicinal, Amino Acid Composition, Flavonoids, Fruits

1. Introduction

In recent years, there has been a consensus that nutrition plays an important role in preventing many diseases. Consequently, healthy lifestyles, healthy diets, and the use of medicinal plants have become increasingly popular. The genus *Cornus* is a member of the Cornaceae family, which includes about 65 species, that are mostly trees and shrubs [1] [2]. The genus *Cornus* (commonly referred to as dogwood), due to its hard woody stem, grows in Eurasia, North America,

Northern South America, and Sub-Saharan Eastern Africa [3].

Most species are used as ornamentals, and only a few species are grown for their fruits, such as *Cornus mas* L., cornelian cherry, due to its better fruit characteristics. This species primarily grows in the temperate zone of Eurasia, and it is highly tolerant to diverse abiotic and biotic conditions. It ranges from a shrub to a small tree with edible olive-shaped fruits [4].

The high content of organic acid, vitamin C and first of all anthocyanins of high antioxidant potential in connection with characteristic aroma and attractive red-ruby color states for great potential of cornelian cherry as raw material for the food industry [5].

Numerous investigations have proved Cornelian cherry fruits and products made of them to be characterized by an exceptionally rich phenolics composition [6], and by other health-promoting properties like e.g. hypocholesterolemic [7] or anti-inflammatory ones [8] [9].

Modern pharmacologic studies have shown that Cornelian cherry covers a range of biological features such as antidiabetic, lipid-lowering, antioxidant, anti-inflammatory, antibacterial, anticancer, anticoagulant, antiparasitic effects and protective effect on liver and kidney function as well as the influence on the cardiovascular system and blood factors [10] [11]. Phytochemical investigations on different parts of this plant have resulted in the identification of 101 compounds, among which anthocyanins, flavonoids and iridoids are the predominant groups. The crude extracts of fruits and other parts of the plant and their pure isolates exhibit a broad spectrum of pharmacological activities such as anti-microbial, anti-diabetic, anti-atherosclerotic, cyto-, hepato-, neuro- and renalprotective, antiplatelet and antiglaucomic activities. Anthocyanins, flavonoids, iridoids and vitamin C are the major bioactive constituents of the fruits. Fruits are non-toxic and safe food on acute toxicity studies in rat and human models. Clinical trials in diabetic type 2 and hyperlipidemic patients showed significant trends of amelioration in sugar level, insulin secretion in diabetic patients and amelioration of lipid profile, apolipoprotein status and vascular inflammation in hyperlipidemic patients [12].

People use Cornelian cherry fruits to treat gastrointestinal disorders and diarrhea in Turkey. Cornelian cherry in the traditional medicine of the Caucasus and Central Asia has been used for more than 1000 years. In some Asian countries, like China and Iran, Cornelian cherries are the main component of plant products used in the treatment of diabetes [13].

Despite several medicinal properties of the plant, it has not been sufficiently studied in Uzbekistan. Since its fruits are used in medicine, their chemical composition was analyzed. This, in turn, allows us to analyze how the composition of plants introduced in our country has changed.

Cornelian cherry (*Cornus mas* L.) is a deciduous shrub or small tree growing 2 - 6 m tall, exceptionally reaching 8 - 9 m [14]. Young shoots are green, later from yellow-gray to reddish-brown. Vegetative buds are small, narrowly oblong,

pointed, somewhat lagging behind, green-brown, covered with a pair of oblong pubescent kidney scales. Flower buds are large, rounded, with a pointed apex, yellow-brown, pubescent. Flowers are bisexual, yellow, four-membered, 17 - 27 pcs in umbellate cymose inflorescences. The fruit is an oblong, red drupe 2 cm long and 1.5 cm in diameter (**Figure 1**), containing a single seed. The fruit is edible, but the unripe is astringent. The most common use of cornelian cherry fruits is to produce different drinks, sweets, gels, and jams [15]. The fruit's length is 2 cm, width 1.5 cm and their weight is from 5 to 8 g. The seed forms 5.7% - 11% of total fruit weight. Fruit, leaf, flower, and tree trunks are used in traditional and modern medicine to treat a variety of disorders. Not only because of its nutritious and delicious fruits but also because of being an attractive ornamental plant, it is grown around the world [16].

Fruit harvest yields 500 - 1000 kg per hectare in the case of wild-growing plants, but in orchards the yield can increase even fivefold. Klimenko states that one wild-growing bush of Cornelian cherry can yield 2.8 - 10 kg of fruit, whereas yield reaches 80 kg per bush for trees cultivated in an orchard [17].

Materials and Methods: The studies were carried out in the laboratory “Chemistry of proteins and peptides” of the Institute of Bioorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan.

Fruit samples of *Cornus mas* L. varieties “Elegant” and “Svetlyachok” were collected in different seasons of 2021. The collected fruits were air-dried in darkness at room temperature (20°C).

Phenylthiocarbonyl (PTC) synthesis of free amino acids was carried out according to the method of Steven, Cohen Daviel [18]. Phenylthiocarbonyl (PTC) and its free amino acid derivative (compound) were analyzed by high-performance liquid chromatography (HPLC). Proteins and peptides contained in the aqueous extracts of the samples were precipitated. 1 ml of the supernatant was taken and 1 ml of 20% TCA was added to it. After 10 minutes, it was centrifuged at 8000



Figure 1. Fruits “Svetlyachok” (a) and “Elegant” (b).

rpm for 15 minutes and 0.1 ml of the residual liquid was dried in a lyophilizer. Identification of PTK amino acids was carried out on an Agilent Technologies 1200 chromatograph on a Discovery HS C18 75 × 4.6 mm column. The following mixtures were used 0.14 M CH₃COONa + 0.05% TEA pH 6.4, B: CH₃CN. Flow rate 1.2 ml per minute, absorbance 269 nm. Gradient % V/min: 1% - 6%/0 - 2.5 min; 6% - 30%/2.51 - 40 min; 30% - 60%/40.1 - 45 min; 60% - 60%/45.1 - 50 min; 60% - 0%/50.1 - 55 min.

The content of flavonoids was determined based on the high performance liquid chromatography method [19]. HPLC brand “Agilent-1200” Column Agilent C18 5 µm, 4.6 × 250 mm. The elution was carried out in isocratic mode, a mixture of 0.1% trifluoroacetic acid and acetonitrile in the ratio (70:30) was used as the mobile phase. The volume flow rate of the eluent was 1.0 ml/min, the volume of the injected sample was 10 µl. Length in 254, 290 nm.

2. Result and Discussion

Cornus mas contains biologically active substances: antioxidants, organic acids, di- and polysaccharides, iridoids. In traditional medicine, dogwood berries are used to treat fever, diarrhea, and kidney disease. Clinical studies show that *Cornus mas* berries contain anti-inflammatory, antimicrobial active substances [20] [21] [22]. Undoubtedly, non-traditional medicinal plants introduced in, Uzbekistan are of great importance in pharmaceuticals [23].

Cornus mas is rich in various amino acids. Amino acids are very important for restoring the activity of the body and for its normal functioning. Of the established 10 amino acids, they are essential amino acids (threonine, arginine, valine, methionine, isoleucine, leucine, histidine, tryptophan, phenylalanine, lysine), the total amount of which in the fruits of the “Elegant” variety was 36.51%, and in the variety it was “Svetlyachok” 59.47% (Table 1).

Also, among the established amino acids, the highest concentration of tyrosine was 0.378743 mg/g in the “Elegant” variety, and tryptophan in the “Svetlyachok” variety was 0.977708 mg/g. On the contrary, it was found that the lowest content of glutamine amino acid was found in the “Elegant” variety and is 0.004967 mg/g, and isoleucine (0.006178 mg/g) in the “Svetlyachok” variety, and histidine amino acid was not found in both varieties.

In the two studied varieties, the number of amino acids is somewhat different. The number of amino acids according to their chemical structure in the “Elegant” variety has the following order: aliphatic > aromatic amino acids > acidic dicarboxylic > sulfur-containing > basic diamino acids > imino acids, and in the “Svetlyachok” variety they decrease in the following order: aromatic amino acids > aliphatic > acidic dicarbons > basic diamino acids > sulfur-containing amino acids > imino acids (Figure 2).

The usage methods for determining flavonoid in literature are HPLC, HPLC-DAD, HPLC-DAD-ESI-MS, HPLC-PDA-ESI-MS, LC-MS/MS, UHPLC and HPTLC. In fruits, quercetin, quercetin 3-O-robinobioside, quercetin

Table 1. The amount of amino acids in the fruits of *Cornus mas*.

Amino acid name	Elegant	Svetlyachok
	Concentration (mg/g)	
Aspartic acid	0.05535	0.027542
Glutamic acid	0.132368	0.027847
Serene	0.1332	0.132374
Glycine	0.120444	0.248576
Asparagine	0.122244	0.244206
Glutamine	0.004967	0.062532
Cysteine	0.155775	0.050912
Threonine	0.064207	0.043289
Argenin	0.113892	0.072175
Alanine	0.011269	0.039493
Proline	0.024803	0.041432
Tyrosine	0.378743	0.196295
Valine	0.282642	0.225475
Methionine	0.012217	0.016751
Isoleucine	0.014165	0.006178
Leucine	0.005334	0.007231
Histidine	0	0
tryptophan	0.030521	0.977708
Phenylalanine	0.125973	0.193093
Lysine	0.006123	0.030126
Total	1.794235	2.643235

3-O-glucuronide, quercetin-3-O-xyloside, quercetin-3-O-rhamnoside, quercetin-3-O-glucoside, quercetin-3-O-ga-lactoside, kaempferol 3-O-galactoside, kaempferol 3-glucoside, myricetin, myricetin 3-galactoside, aromadendrin are found in fruits of CM whereas in the leaves, quercetin 3-O-glucuronide is the major flavonoid compound. Total flavonoids vary depending on the country of origin. Determination of total flavonoids were assessed with the aluminum nitrate colorimetric method, and a procedure described by Fukumoto and Mazza (2000). Total flavonoids range between 0.5 and 207 mg quercetin equivalents (QE)/g dw in Turkey; 3.21 and 6.69 mg CAT/g fw in Iran; and 0.09 and 0.1 mg/g dw in Poland. The total amount of flavonoids varies according to different solutions. Karaaslan, Karaaslan, and Ates showed that acetone extract of CM fruits gives the highest total flavonoid contents. Abbasi *et al.* found the mean total flavonoids are $0.07\% \pm 0.01\%$ dw in 70% methanol extract of CM fruits [24] [25] [26].

As a result of our studies, the amount of flavonoids (apigenin, luteinin, rutin,

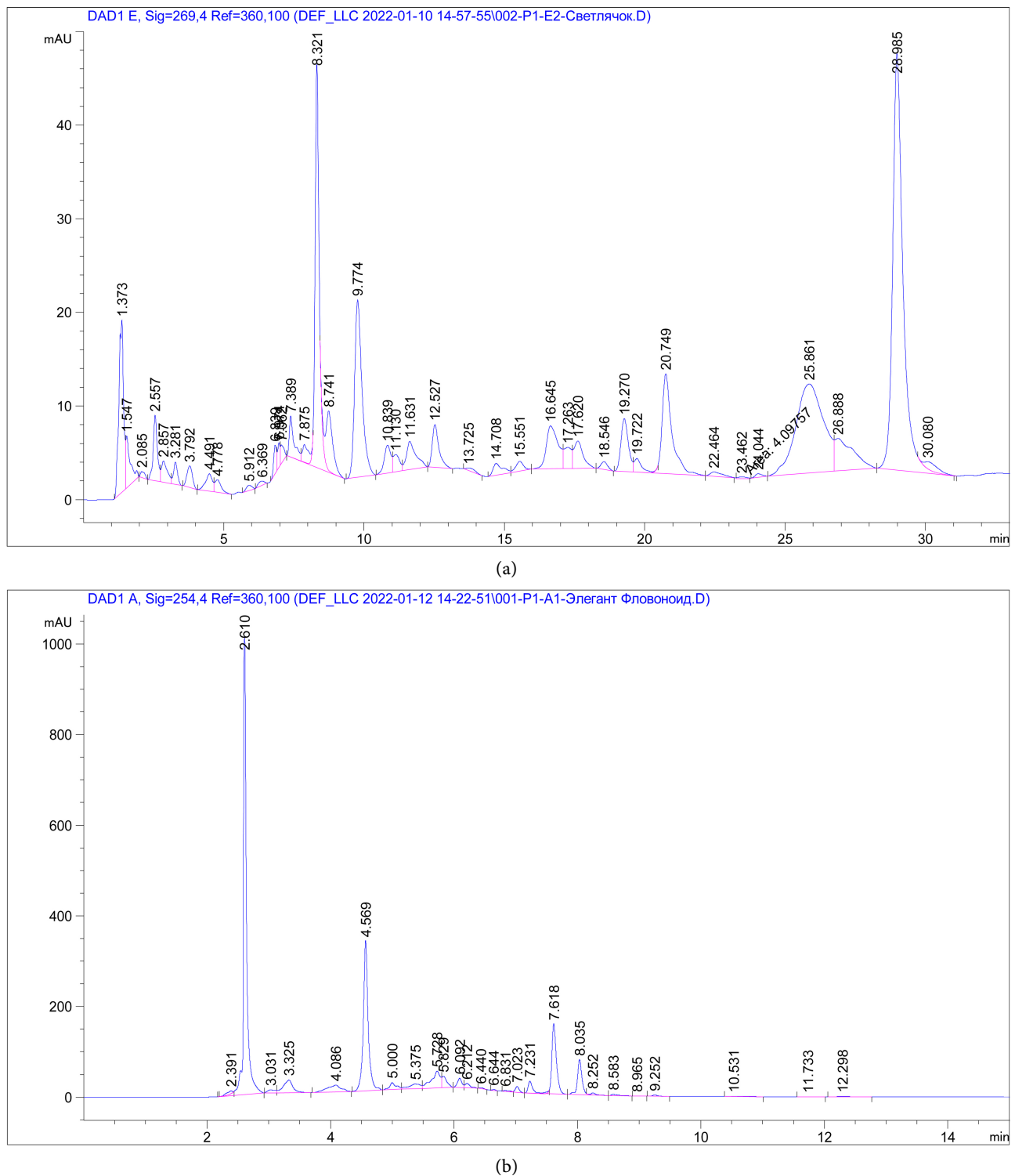


Figure 2. Chromatogram of the amino acid of the fruits of the varieties “Svetlyachok” (a) and “Elegant” (b).

quercetin) was determined in the composition of dogwood fruits of the elegant and firefly varieties (**Table 2**).

In the composition of berries, the largest amount of apigenin was found in the Svetlyachok variety and amounted to 0.68 mg/g. On the contrary, in the fruits of

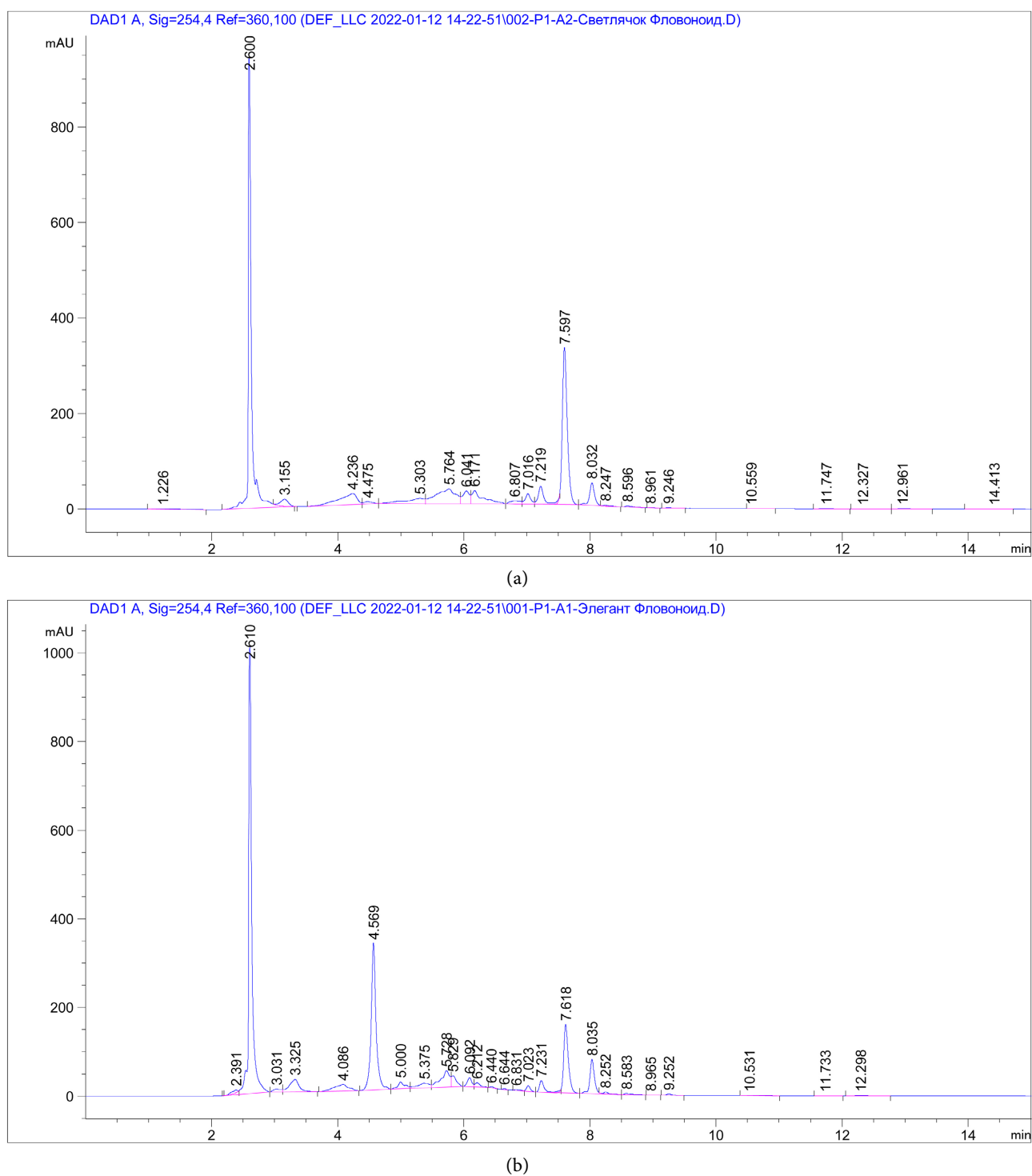


Figure 3. Chromatogram of flavonoids of fruits of varieties “Svetlyachok” (a) and “Elegant” (b).

the “Elegant” variety, the concentration of apigenin was 1.8 times lower.

The amount of rutin and quercetin flavonoids in Elegant was 3.59 mg/g and 0.24 mg/g, respectively. It has been established that in the variety “Svetlyachok” the amount of rutin is lower than that of the above variety, and the amount of quercetin, on the contrary, is higher (**Figure 3**).

Table 2. The amount of flavonoids in fruits of *Cornus mas* L.

Flavonoids	Elegant	Svetlyachok
	Concentration (mg/g)	
Apigenin	0.364	0.68
Luteolin	1.8	0.24
Rutin	3.59	3.26
Quercetin	0.24	0.46

Thus, the determination of flavonoids in the composition of medicinal plants and their quantitative indicators is of great practical importance. For the first time, the analysis of the content of flavonoids in the fruits of *Cornus mas* L., growing in our conditions, was carried out. As a result of our research, for the first time, the amount of 20 amino acids in the fruits of two varieties of *Cornus mas* L. was established. The amount of amino acids contained in these varieties was the largest in the fruits of the variety “Svetlyachok” 2.643235 mg/g, and the percentage of essential amino acids was 59.47%, respectively. It was revealed that the largest amount of amino acids is contained in the variety “Svetlyachok” —2.643235 mg/g.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Czerwinska, M.E. and Melzig, M.F. (2018) *Cornus mas* and *Cornus officinalis*—Analogies and Differences of Two Medicinal Plants Traditionally Used. *Frontiers in Pharmacology*, **9**, Article 894. <https://doi.org/10.3389/fphar.2018.00894>.
- [2] Dinda, B., Kyriakopoulos, A.M., Dinda, S., Zoumpourlis, V., Thomaidis, N.S., Velegraki, A. and Dinda, M. (2016) *Cornus mas* L. (Cornelian Cherry), an Important European and Asian Traditional Food and Medicine: Ethnomedicine, Phytochemistry and Pharmacology for Its Commercial Utilization in Drug Industry. *Journal of Ethnopharmacology*, **193**, 670-690. <https://doi.org/10.1016/j.jep.2016.09.042>.
- [3] Atkinson, B.A., Stockey, R.A. and Rothwell, G.W. (2016) Cretaceous Origin of Dogwoods: An Anatomically Preserved *Cornus* (Cornaceae) Fruit from the Campanian of Vancouver Island. *PeerJ*, **4**, e2808. <https://doi.org/10.7717/peerj.2808>
- [4] Moradia, Y., Khadivvia, A. and Salehi-Arjmand, H. (2019) Morphological and Pomological Characterizations of Cornelian Cherry (*Cornus mas* L.) to Select the Superior Accessions. *Scientia Horticulturae*, **249**, 208-218. <https://doi.org/10.1016/j.scienta.2019.01.039>

- [5] Tarko, T., Duda-Chodak, A., Satora, P., Sroka, P., Pogoń, P. and Machalica, J. (2014) Chaenomeles Japonica, *Cornus mas*, Morus Nigra Fruits Characteristics and Their Processing Potential. *Journal of Food Science and Technology*, **51**, 3934-3941. <https://doi.org/10.1007/s13197-013-0963-5>
- [6] De Biaggi, M., Donno, D., Mellano, M.G., Riondato, I., Rakotoniana, E.N. and Beccaro, G.L. (2018) *Cornus mas* (L.) Fruit as a Potential Source of Natural Health-Promoting Compounds: Physicochemical Characterisation of Bioactive Components. *Plant Foods for Human Nutrition*, **73**, 89-94. <https://doi.org/10.1007/s11130-018-0663-4>
- [7] Hosseinpour, F., Shomali, T. and Rafeian-Kopaei, M. (2017) Hypocholesterolemic Activity of Cornelian Cherry (*Cornus mas* L.) Fruits. *Journal of Complementary and Integrative Medicine*, **14**, Article. No. 20170007. <https://doi.org/10.1515/jcim-2017-0007>
- [8] Adamenko, K., Kawa-Rygielska, J., Kucharska, A.Z. and Piórecki, N. (2018) Characteristics of Biologically Active Compounds in Cornelian Cherry Meads. *Molecules*, **23**, 2024. <https://dx.doi.org/10.3390%2Fmolecules23082024>.
- [9] Moldovan, B., Filip, A., Clichici, S., Suharoschi, R., Bolfa, P. and David, L. (2016) Antioxidant Activity of Cornelian Cherry (*Cornus mas* L.) Fruits Extract and the in vivo Evaluation of Its Anti-Inflammatory Effects. *Journal of Functional Foods*, **26**, 77-87. <https://doi.org/10.1016/j.jff.2016.07.004>
- [10] Asgary, S., Rafeian-Kopaei, M., Shamsi, F., Najafi, S. and Sahebkar, A. (2014) Biochemical and Histopathological Study of the Anti-Hyperglycemic and Anti-Hyperlipidemic Effects of Cornelian Cherry (*Cornus mas* L.) in Alloxan-Induced Diabetic Rats. *Journal of Complementary and Integrative Medicine*, **11**, 63-69. <https://doi.org/10.1515/jcim-2013-0022>
- [11] Asgary, S., Kelishadi, R., Rafeian-Kopaei, M., et al. (2013) Investigation of the Lipid-Modifying and Antiinflammatory Effects of *Cornus mas* L. Supplementation on dyslipidemic Children and Adolescents. *Pediatric Cardiology*, **34**, 1729-1735. <https://doi.org/10.1007/s00246-013-0693-5>
- [12] Dinda, B., Kyriakopoulos, A.M., Dinda, S., Zoumpourlis, V., Thomaidis, N., Velegraki, A., Markopoulos, C. and Dinda, M. (2016) *Cornus mas* L. (Cornelian Cherry), an Important European and Asian Traditional Food and Medicine: Ethnomedicine, Phytochemistry and Pharmacology for Its Commercial Utilization in Drug Industry. *Journal of Ethnopharmacology*, **193**, 670-690. <https://doi.org/10.1016/j.jep.2016.09.042>
- [13] Jayaprakasam, B., Vareed, S.K., Olson, L.K. and Nair, M.G. (2005) Insulin Secretion by Bioactive Anthocyanins and Anthocyanidins Present in Fruits. *Journal of Agricultural and Food Chemistry*, **53**, 28-31. <https://doi.org/10.1021/jf049018>
- [14] Da Ronch, F., Caudullo, G., Houston Durrant, T. and de Rigo, D. (2016) *Cornus mas* in Europe: Distribution, Habitat, Usage and Threats. *European Atlas of Forest Tree Species Tree Species*, **8**, 82-83.
- [15] Pawlowska, A.M., Camangi, F. and Braca, A. (2010) Quali-Quantitative Analysis of Flavonoids of *Cornus mas* L. (Cornaceae) Fruits. *Food Chemistry*, **119**, 1257-1261. <https://doi.org/10.1016/j.foodchem.2009.07.063>
- [16] Hosseinpour-Jaghdani, F., Shomali, T., Gholipour-Shahraki, S., Rahimi-Madiseh, M. and Rafeian-Kopaei, M. (2017) Cornusmas: A Review on Traditional Uses and Pharmacological Properties. *Journal of Complementary and Integrative Medicine*, **14**, 20160137. <https://doi.org/10.1515/jcim-2016-0137>
- [17] Szczepaniak, O.M., Kobus-Cisowska, J., Kusek, W. and Przeor, M. (2019) Function-

- al Properties of Cornelian Cherry (*Cornus mas* L.): A Comprehensive Review. *European Food Research and Technology*, **245**, 2071-2087. <https://doi.org/10.1007/s00217-019-03313-0>
- [18] Steven, A. and Cohen Daviel, J. (1988) Amino Acid Analysis Utilizing Phenylisothiocyanate Derivatives. *Analytical Biochemistry*, **174**, 1-16. [https://doi.org/10.1016/0003-2697\(88\)90512-X](https://doi.org/10.1016/0003-2697(88)90512-X)
- [19] Georgievsky, V.P., Komisarenko, N.F. and Dmitruk, S.E. (1990) Biologically Active Substances of Medicinal Plants. Novosibirsk: Science: Siberian Branch, Moscow.
- [20] Sergeevich, P.A. (2016) Formation of Dogwood Productivity in the Central Chernozem Region and Suitability for Obtaining Healthy Food Products Abstract. Dissertation for a Degree. Michurinsk-Science City of the Russian Federation.
- [21] Perova, I.B., Zhogova, A.A., Poliakova, A.V., Éller, K.I., Ramenskaia, G.V. and Samylina, I.A. (2014) Biologically Active Substances of Cornelian Fruit (*Cornus mas* L.). *Nutritional issues*, **83**, 86-87.
- [22] Lugovoi, I.S., et al. (2014) Morphological and Anatomical Study of the Stem and Buds of Common Dogwood *Cornus mas* L. Families Dogwood. *Pharmacy and Pharmacology*, **6**, 18-21. [https://doi.org/10.19163/2307-9266-2014-2-6\(7\)-18-21](https://doi.org/10.19163/2307-9266-2014-2-6(7)-18-21)
- [23] Nurullayeva, N., Haydarov, K., Umurzakova, Z. and Safarova, D. (2021) Growth and Development of *Lycium barbarum* L. in the Environment of Samarkand in Uzbekistan. *Plant Science Today*, **8**, 278-282. <https://doi.org/10.14719/pst.2021.8.2.919>
- [24] Bayram, H.M. and Ozturkcan, S.A. (2019) Bioactive Components and Biological Properties of Cornelian Cherry (*Cornus mas* L.): A Comprehensive Review. *Journal of Functional Foods*, **75**, 2071-2087. <https://doi.org/10.1016/j.jff.2020.104252>
- [25] Deng, S., West, B.J. and Jensen, C.J. (2013) UPLC-TOF-MS Characterization and Identification of Bioactive Iridoids in *Cornus mas* Fruit. *Journal of Analytical Methods in Chemistry*, **2013**, Article ID: 710972. <https://doi.org/10.1155/2013/710972>
- [26] Milenkovic-Andjelkovic, A., Andjelkovic, M., Radovanovic, A., Radovanovic, B. and Nikolic, V. (2015) Phenol Composition, DPPH Radical Scavenging and Antimicrobial Activity of Cornelian Cherry (*Cornus mas*) Fruit and Leaf Extracts. *Chemistry & Industry*, **69**, 331-337. <https://doi.org/10.2298/HEMIND140216046M>