



AMELANCHIER MEDIK. (ROSACEAE) FRUITS – A NUTRITION DIETARY PRODUCT AND A SOURCE MATERIAL FOR PHYTOPHARMACOLOGY

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Fruits of *Amelanchier spicata* (Lam.) K.Koch, *Amelanchier alnifolia* (Nutt.) Nutt.), *Amelanchier florida* Lindl., *Amelanchier canadensis* (L.) Medik. and *Amelanchier laevis* Wieg. (Rosaceae) are rich in ascorbic acid (up to 30.3 mg%), total sugar (up to 8.7%), they are also saturated with bioflavonoids, among which there are anthocyanins (353.1–608.2 mg%), possessing antioxidant qualities. *Amelanchier* fruits are the nutritious dietary product, in which the content of acids and sugars is balanced. They are suitable for various types of processing and can serve as phytopharmacological raw materials. Biochemical analysis of leaves of *Amelanchier spicata* and *Amelanchier alnifolia* showed that they are enriched with bioflavonoids (260–370 mg%), which is also valuable for phytopharmacology. *Amelanchier alnifolia* and closely related *Amelanchier florida* have especially large and delicious fruits, more enriched with saccharides and anthocyanins. They have prospects for a further selection as a highly productive garden and food culture. *Amelanchier laevis* plants luxuriantly bloom, but they differ in an irregular fruit bearing and smaller fruits (0.6 g in weight), they are promising as an ornamental culture.

Keywords: adventisation; naturalization; invasive activity; anthropogenic transformation

Introduction

Species of the genus *Amelanchier* Medik. (Maloideae, Rosaceae) are used as a decorative and a fruit culture. The nutritional qualities and chemical composition of the fruit are better studied in Saskatoon (*Amelanchier alnifolia* (Nutt.) Nutt.) – native to the North American plains. Its dark-purple, berry-like pome fruit range in diameter from 10 to 15 mm in average. Fruits are sweet, contain up to 14–19% of sugar and consist of fructose and glucose. The amount of pectins is 0.25–0.95 mg per a gram of wet weight. The malic dominates among the organic acids (0.63%). Fruit pH ranged 3.65–4.18. The fruits of Saskatoon are full of biologically active substances – thiamine (30 mkg%), riboflavin (12 mkg%), carotenoids (about 0.3 mg%) and ascorbic acid (8–61 mg%). Among bioflavonoids (0.5–1.6%) there are catechins (70–163 mg%), flavonols (30–160 mg%). Among the oxycinnamic acids there are chlorogenic (up 291 mg%), para-coumaric (30–69 mg%) and caffeic acids (7–22 mg%) with hepatoprotective activity (Стрельцина, Бурмистров, 2006). The bright coloration of juice of the Saskatoon fruit is due to the presence of anthocyanin (414–852 mg%), analysis identified cyanidin-3-galactoside, cyanidin-3-glucoside (Mazza, 1986; Ozga et al., 2006), and cyanidin-3-arabinoside (Чулков и др., 2011) and delphinidine (Писарев и др., 2011).

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In the fruits of Saskatoon there are 67.5 mg of manganese, 67.0 mg of iron, 31.8 mg of sodium, 7.2 mg of copper, 16.5 mg of zinc, 34.8 mg of barium, 0.38 mg of molybdenum and aluminum 74.5 mg/100 g wet weight, as well as 0.44% calcium, 0.16% phosphorous, 1.2% potasse, 0.2% magnese, 0.06% sulfur, 9.7% protein and 19% of fiber (Mazza, 1982; Zatylny et al., 2005).

In Russian Botanical Gardens, *Amelanchier spicata* (Lam.) K.Koch, *Amelanchier alnifolia*, which got naturalized in forests and became invasive plants, are often cultivated (Kuklina, 2011). The fruits of *Amelanchier spicata* weigh 0.27–0.38 g, they are on a short panicle of 4–10 pieces; *Amelanchier alnifolia* fruits are larger, weigh 0.41–0.65 g, on a panicle of 10–15 pieces. They are purple-black with a bluish bloom. They are appreciated for their flavouring qualities, are used in food and in folk medicine. Fruits are useful for health promotion, especially for diseases of liver, kidneys, stomach and heart. Fresh, dried and air-dried fruits have astringent properties, they help with digestive disorders (Сорокопудов и др., 2011; Виноградова и Куклина, 2012).

There are also *Amelanchier florida* Lindl., *Amelanchier canadensis* (L.) Medik. and *Amelanchier laevis* Wieg planted in Russia. Juice, jam, confiture, jelly are made from the *Amelanchier* fruits; brightly colored drinks are made with citric acid – stewed fruit and wine (Якушина и Куклина, 1994; Куклина, 2007).

The goal of this work includes a study of the weight and a biochemical composition of fruits in the 5 *Amelanchier* species cultivated in Central Russia, in connection with a possibility of its use for nutrition and phytopharmacology.

Materials and methodology

The 5 species was used as the material: *Amelanchier spicata*, *Amelanchier alnifolia*, *Amelanchier florida*, *Amelanchier canadensis* and *Amelanchier laevis*, cultivated in the Main Botanical Garden named after N.V. Tsitsin, Russian Academy of Sciences (Moscow) and in the Botanical Garden of Belgorod, National Research University (Belgorod). The biochemical analysis was carried out in the period 2010–2016 on fresh fruits harvested during the full ripeness phase. Every year we analyzed samples from 10 shrubs belonging to 5 species of *Amelanchier*. Dry soluble substances and the amount of sugars were measured by using an optical refractometer IRF-454-Б 2М (Russia); Ascorbic acid – by tilting the extracts with Tilmans paint with the help of the spectrophotometer CF-102 (Russia), anthocyanins – by the spectrophotometric method. The amount of bioflavonoids was determined by the chromatographic method, the content of organic acids by titration method according to the “State Pharmacopoeia USSR, XI” (www.fito.nnov.ru/pharmacopaea) on dry fruits. The results were processed in Microsoft Excel. The permissible error did not exceed the norm ($P \leq 5\%$).

Results and discussion

The 5 species of *Amelanchier* under analysis, showed a good winter-hardiness in the conditions of Central Russia, and an annual abundant flowering. An inflorescence of *Amelanchier spicata*, 6 cm long, contains up to 11 fruits weighing about 1 g; an inflorescence of *Amelanchier alnifolia*, 6 cm in length, contains up to 9 fruits weighing 0.6–1.1 g; that of *Amelanchier florida* 5 cm long contains up to 11 fruits weighing 0.79–0.99 g; that of *Amelanchier canadensis* 6 cm long contains up to 12 fruits 0.6–0.98 g in weight, and that of *Amelanchier laevis* 4.5 cm long contains up to 8 fruits, which are formed not annually, with their weight of 0.52–0.78 g.

According to our data, dry fruits *Amelanchier spicata* and *Amelanchier alnifolia* have total bioflavonoids (quercetin, vitexin, 4-rhamnocide vitexin, hyperoside) – 180–410 mg%. Among the

bioflavonoids in the *Amelanchier* fruits the leading place is occupied by anthocyanins with up to 2150 mg% per dry weight (Куклина и др., 2017), or up to 840 mg per wet weight (Стељцина и Бурмистров, 2006), thanks to which the juice has a bright crimson color. On this basis *Amelanchier* fruits, saturated with biologically active in combination with trace elements, have a therapeutic value and can serve as a source material for phytopharmacology.

As it is shown in Table 1, the fruits of the five species of *Amelanchier* contain up to 40 mg% of ascorbic acid and 30.3% of soluble solids. The juice of ripe fruit has a sum of anthocyanin (353–608 mg%).

Table 1 The chemical composition of *Amelanchier* spp. fruits from Belgorod, in 2010–2015

Species	Soluble solids, %	Ascorbic acid, mg%	Total anthocyanin content, mg%
<i>A. spicata</i>	30.3 ± 1.3	40.2 ± 1.6	408.4 ± 20.8
<i>A. alnifolia</i>	30.1 ± 1.5	43.8 ± 1.1	482.8 ± 12.6
<i>A. florida</i>	27.3 ± 1.0	40.3 ± 1.7	608.2 ± 15.9
<i>A. canadensis</i>	29.2 ± 1.0	42.8 ± 1.7	458.7 ± 29.7
<i>A. laevis</i>	23.9 ± 1.1	41.2 ± 1.2	353.1 ± 24.1

The taste and dietary properties of fruits depend on the ratio of sugars and organic acids. The amount of sugars, among of which monosaccharides prevail, in the fruits of *Amelanchier* changed insignificantly (within 7.3–8.8%, CV = 1–3%), despite the annual fluctuations in weather conditions and the dry summer of 2010 (Table 2).

Table 2 Total sugar of *Amelanchier* spp. fruits from Belgorod (%), in 2010–2013

Species	2010	2011	2012	2013	M ± m, %
<i>A. spicata</i>	7.9 ± 0.3	7.3 ± 0.5	7.5 ± 0.9	7.6 ± 1.1	7.6 ± 0.2
<i>A. alnifolia</i>	7.5 ± 1.1	8.3 ± 0.2	8.3 ± 0.6	8.6 ± 0.6	8.4 ± 0.1
<i>A. florida</i>	8.8 ± 0.2	8.5 ± 0.4	8.3 ± 0.8	8.6 ± 0.9	8.7 ± 0.2
<i>A. canadensis</i>	8.1 ± 0.2	8.3 ± 0.5	8.0 ± 0.8	8.1 ± 1.0	8.1 ± 0.1
<i>A. laevis</i>	8.8 ± 0.4	8.4 ± 0.6	8.2 ± 0.9	8.1 ± 1.1	8.4 ± 0.3

The sweetest fruits were noted in *Amelanchier florida* (8.7%), as well as in *Amelanchier alnifolia* and *Amelanchier laevis* (8.4%). Less sugar was found in fruits of *A. spicata* (7.6%). In 2015–2016 we established, that dried fruits of *A. spicata* were almost 1.5 times more saturated with organic acids (0.75–0.99%), than those of *A. alnifolia* (0.49–0.64%).

The study revealed high positive correlations between the content of dry soluble substances and sugars ($r = 0.999$), which is a reliable criterion for the selection of highly productive cultivars. After harvesting *Amelanchier* fruits can be stored at room temperature for 2–3 days, and at temperature of 0–10 °C – up to 7 days, and the juice yield amounts to 70% (Степанова, 2015).

It is known that in folk medicine decoctions of leaves are used to rinse the mouth with purulent inflammation, stomatitis and help with gastrointestinal diseases. Biochemical analysis of *Amelanchier spicata* and *Amelanchier alnifolia* samples showed that not only fruits but also leaves

are enriched with bioflavonoids (260–370 mg%), which are also valuable for phytopharmacology (Куклина и др., 2017).

Conclusions

In *Amelanchier spicata*, *Amelanchier alnifolia*, *Amelanchier florida*, *Amelanchier canadensis* and *Amelanchier laevis*, the panicle is from 4.8 to 7.3 cm in length. Mature fruits further differ in the balanced content of sugars (up to 8.8%) and organic acids (up to 0.99%), therefore they are a nutritious and dietary product important in the human diet. The presence of ascorbic acid (more than 40 mg%) and bioflavonoids, among which anthocyanins prevails (up to 608 mg%), makes the fruit necessary to improve immunity against viral and oncoidiseases, useful in cardiovascular disorders. *Amelanchier* fruits are a valuable source material for phytopharmacology.

The studied plant species are unequal in their nutritional advantages and adaptive possibilities in natural biocenoses. Especially large and delicious fruits, more enriched with saccharides and anthocyanins, have *Amelanchier alnifolia* and closely related *Amelanchier florida*, which have prospects for a further selection as a highly productive garden and food culture. *Amelanchier laevis* plants in Russia are rather luxuriantly blooming and elegant, but they differ in an irregular fruit bearing and smaller fruits (0.6 g in weight), they are promising as an ornamental culture, like species of *Amelanchier canadensis*, suitable for the landscape gardening.

The spread of *Amelanchier spicata* in culture should be limited, as far as its highly adapted individuals are capable of active growing due to their long hypogeogenic rhizomes and spreading seeds, and pose a serious threat to the native flora (Kuklina, 2011); and their fruits, although they can be used as a medical source materials, are characterized by weaker flavouring qualities.

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