Fruit Growing Research, Vol. XXXVIII, 2022
https://publications.icdp.ro/index.php
DOI 10.33045/fgr.v38.2022.33

# EVALUAREA CALITĂȚILOR FIZICO-CHIMICE ALE FRUCTELOR DE AFIN
# THE EVALUATION OF THE PHYSICO-CHEMICAL QUALITIES OF BLUEBERRY FRUITS

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**Abstract**

**In last years, highbush blueberry (*Vaccinium corymbosum L.*) has gained great popularity, mainly due to its appreciated taste and multiple uses. The biochemical composition of blueberries has an important role in health and nutrition. Studies have shown that bioactive compounds can reduce the risk of many diseases. This study was conducted over a period of three years to assess the size of the fruit average weight per fruit, diameter, firmness, total titratable acidity, color, total soluble solids (°Brix), pH, but also the total content of bioactive compounds such as polyphenols, flavonoids, anthocyanins, tannins and carotenoids, along with vitamin C and total sugar. Three blueberry genotypes ('Azur', 'Delicia', and 'Northblue') and two advanced selections ('4/6', and '6/38') were studied. The plants were grown at the Research Institute for Pomiculture Pitesti - Maracineni, Romania, in open field studies in randomized block with three repetitions (5 plants/ genotype/ repetition). The researches showed the following: the average weight / plant recorded values between 2.07 g ('Northblue' cv.) and 2.64 g ('6/38'); the size of the fruit varied between 12.10 mm ('4/6') and 17.45 mm ('Azur' cv.); the firmness had values between 15.33 N ('Northblue' cv.) and 18.45 N ('Azur' cv.); total titratable acidity of highbush blueberry increased from 0.625% for '4/6' elite to 0.960% for 'Northblue' cv.); total soluble solids varied between 12.9 °Brix ('6/38') and 15.59 °Brix ('Delicia' cv.); colorimetry ranged from 27.19 (L*), 0.19 (a*), -2.66 (b*) ('Azur' cv.) to 34.23 (L*), 0.72 (a*), -3.13 (b*) ('Delicia' cv.). Total polyphenols recorded values between 284.4 mg gallic acid equivalent (GAE) g/ 100 g fresh weight (fw) ('Azur' cv.) and 481.6 mg GAE/100 g fresh weight ('Northblue' cv.); total flavonoids had values between 110.6 mg catechin equivalents/100 g) CE /100 g ('Delicia' cv.) and 160.8 mg CE/100 g ('6/38'); total anthocyanins recorded values between 10.35 mg cyanidin-3-O-glucoside equivalents (C 3-G)/100 fresh weight ('Azur' cv.) and 56.03 mg cy3GE/100 g ('6/38'); total tannins varied between 160.5 mg GAE/100 g ('6/38') and 335.2 mg GAE/100 g ('4/6'); total sugar varied between 21.14 g glucose/100 g ('Northblue' cv.) and 30.67 g glucose /100 g ('Azur' cv.), and vitamin C content had values between 2.27 mg/100 g ('Azur' cv.) and 5.85 mg/100g ('Delicia' cv. and '6/38'). These genotypes having highest physico-chemical qualities could be used in blueberry breeding programs in order to obtain new genotipes.**

**Cuvinte cheie:** *Vaccinium corymbosum L.,* genotipuri, compuși bioactivi,
**Key words:** *Vaccinium corymbosum L.,* genotypes, bioactive compounds.

## 1. Introduction

In Romanian Pomology, vol. VII, published in 1968, blueberry belongs to the *Vaccinium* Genus, *Ericaceae* Family, *Ericales* Order. *Vaccinium corymbosum* (highbush blueberry) is widespread along the Atlantic coast from Florida to Maine, West and South Michigan in the US as well as in eastern Canada (Ballington et al., 2001). The highbush blueberry grows to 2-3 m in height.

The blueberry is a species with economic and food interest due to their high production potential. The plant yield's quality and quantity depend on pollen viability and germination capacity. Bioactive compounds found in the blue epidermis fruits have strong antioxidant, anti-inflammatory, antibacterial effect, blueberries having an elevated antioxidant capacity. Nutritional value of fruits indicates that blueberries are a high source of minerals (Ca, K, Na, Mg, Zn, Fe), vitamins (A, C, B1, B2), but also protein (Hera et al, 2021). The consumers have begun to be interested not only in the taste of the fruits and its products, but also in the positive effects of secondary metabolites on human health (Saridaș et al.).

The objective of this study was the evaluation of the physico-chemical qualities of blueberry fruits grows under climatic conditions in Romania.

## 2. Material and methods

The experiment was in an open field trial in randomized block design with three repetitions plots (5 plants/ genotype/ repetition) between 2019-2021, at the Research Institute for Fruit Growing Pitești-Mărăcineni (RIFG), in South of Romania at 44°54'12" Northern latitude, and 24°52'18" Eastern longitude, 284 m altitude. The soil type prevailing in the field trial belongs to the protisoil class, humid aluviosoil type, formed on fluvial deposits with a clayey and sandy granulometric composition. Soil is characterized by acidic reaction (pH 5.85), humus % 2.52, $P_2O_2$ 15.2 ppm, also N total % 0.1.

There were studied 3 blueberry cultivars 'Delicia', 'Azur', and 'Northblue' and two advanced selections '4/6', and '6/38' planted at a distance of 1 x 0.50 m. Blueberries were harvested at the full maturity stage, at the beginning of July. After harvesting the blueberries were stored, frozen at -4 °C until to perform the analysis. The indicators studied were recorded on a sample a 20 blueberry fruits. Fruit production was determined by weighing ripened berries at each harvested and then summing all harvests.

The average fruit weight was determined by weighing of each fruit using HL-400 digital. The fruit firmness was determined for each sample with a penetrometer Bareiss HPE II Fff nondestructive test, with a measuring surface of 0.25 cm². The length and diameter of the fruit were determined by measuring this using digital caliper. The soluble solids content was determined with digital refractometer PR Series. The external fruit color was determined with a colorimeter Konica Minolta CR 400, based on system Huntel L*, a*, b* on both sides of the fruit (L* corresponds to brightness, a* and b* chromaticity coordinates from green to red and blue to yellow).

The total polyphenols content was determined according to the methodology suggested by Matić et al., 2017. The total flavonoids content was determined according to the method described in Tudor-Radu et al., 2016. The determination of the anthocyanins content was made according to the methodology suggested by Di Stefano and Cravero, 1989. The total sugar content was performed using the colorimetric method and the methodology suggested by Dubois et al., 1956. The content of vitamin C was determined by using 2,6-dichloroindophenol (DCPIP), at pH 3-4.5. Also the contents of titratable acids, soluble solids, anthocyanins, the total sugar content, tannins of frozen fruits of highbush blueberry genotypes were analised.

Statistical analysis was performed using IBM SPSS 14 program (SPSS Inc., Chicago, IL, USA). All results were statistically evaluated by analysis of variance (ANOVA). Differences between cultivars were highlighted through Duncan's multiple test range ($p< 0.005$). Graphical representations were performed with Microsoft Office Excel 2007.

## 3. Results and discussions

The results showed significant differences between all genotypes and all investigated parameters.

The berry weight and fruit diameter depends on genotype and ecological factors. Berry's average weight (Fig. 1) varied between 2.07 g for 'Northblue' cv. to 2.64 g for '6/38' elite. The highest values of the fruit diameter (Fig. 1) were registered by the genotypes 'Azur' (17.45 mm) and 'Delicia' (17.43 mm), but the elite '4/6' had the lowest fruit diameter (12.10 mm).

Phenolic compounds identified from the blueberry cultivars were categorized as anthocyanins, flavonols, flavanones, ellagitannins, and other simple phenolic compounds (Azizah et al., 2015). Mean's values of the five cultivars (Fig. 2) varied from 284.4 mg gallic acid equivalent (GAE)/100 g fresh weight (fw)?? for 'Azur' cv. to 481.6 mg GAE/100 g fw for 'Northblue' cv.

Flavonoids are a large group of polyphenolic compounds that occur commonly in plants. Flavonoids are pigments responsible for the shades of the yellow, orange and red in flowering plant (Pietta et al., 2003). Total flavonoid content in blueberry fruit (Fig. 2) varied between 110.6 mg catechine equivalent (CE)/100 g for 'Delicia' cv. to 160.8 mg CE/100 g for '6/38' elite.

Berries color is reflected by content of anthocyanins, and it is know that blueberry had a higher anthocyanins level than other fruits (Diamanti et al., 2015). The highest level of anthocyanins was found for '6/38' elite with 56.03 mg cyanidin-3-O-glucoside equivalents (C 3-G)/100 g fruit weight (Fig. 3).

The total sugar content is a biochemical indicator used to determine the quality of sweet berries (Okan et al., 2018). In blueberry, sugars and organic acids determine fruit organoleptic quality and drastically change during fruit maturation (Li et al., 2020). In our study, the lowest values for total sugar content were noticed for 'Northblue' cv. (21.14 g glucose/100 g) and '6/38' elite (22.31 g glucose/100 g), also the highest value was found for 'Azur' cv. (30.67 g glucose/100 g).

As presented Fig. 4, total titratable acidity of highbush blueberry increased from 0.625% for '4/6' elite to 0.960% for 'Northblue' cv. Similar values were reported by Saftner et al., 2008 who found values for total acidity of 0.35% to 1.27%.

After Cortes-Rojas et al., 2016, the soluble solids content is a measure of sweetness. In our study, the total soluble solids content (Fig. 5) oscillated from 12.9 °Brix for '6/38' elite to 15.59 °Brix for '4/6' elite. On average, the soluble solids content of the harvested fruits in Colombia was in a range of 12.4 °Brix to 14.5 °Brix.

The firmness is a trait that directly affects the quality of the berries. The firmness of blueberry fruits oscillated between 15.33 N for 'Northblue' cv. to 29.70 N for 'Delicia' cv. (Fig. 5).

The berries pH recorded the normal values for this species, ranged between 3.23 for 'Northblue' cv. to 3.77 for '4/6' elite (Fig. 5).

Regarding the intensity of the color, L*, a* and b* values of the blueberry genotypes were significantly different (Fig. 6). L* increased from 27.19 ('Azur' cv.) to 34.23 ('Delicia' cv.), a* increased from 0.10 ('Northblue' cv.) to 0.72 ('Delicia' cv.) and b* increased from 2.66 ('Azur' cv.) to 3.32 ('4/6' elite.)

## 4. Conclusions

In conclusion, we can say that the blueberry 'Azur' cv. recorded the highest amount of sugars (30.67 g glucose/100 g). The highest fruit firmness value (29.7 N) was recorded by 'Delicia' cv. Also the highest content of fruit in soluble solids (15.59 °Brix), the highest value for L* (34.23), a*(0.72,), b* (-3.13), and the highest amount of vitamin C was registered by 'Delicia' cv. too. 'Azur' and 'Delicia' cvs. can be successfully used in future breeding programs to create fruit quality.

Also, '6/38' elite can be successfully used in future breeding programs to improve fruit quality, especially for the highest value of average weight/fruit (2.64 g), and high concentration of anthocyanins (56.03 mg cyanidin-3-O-glucoside equivalents (C 3-G)/100 100 g), flavonoids (160,8 mg catechin equivalents/100 g). And the highest amount of vitamin C was recorded in the variety 'Delicia', which can be successfully used in future breeding programs to improve fruit quality.

Our results of this study will strengthen the breeding process in the Research Institute for Fruit Growing Pitesti which aims to create new valuable varieties of *Vaccinium corymbosum L.* with a significant complex of biologic active compounds, which makes the fruits of this crop a prevailing food product.

## Acknowledgements

This work of Hera Oana was supported by the project “PROINVENT”, Contract no. 62487/03.06.2022 POCU/993/6/13 – cod SMIS: 153299 financed by The Human Capital Operational Programme 2014–2020 (POCU), Romania.

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**Figures**

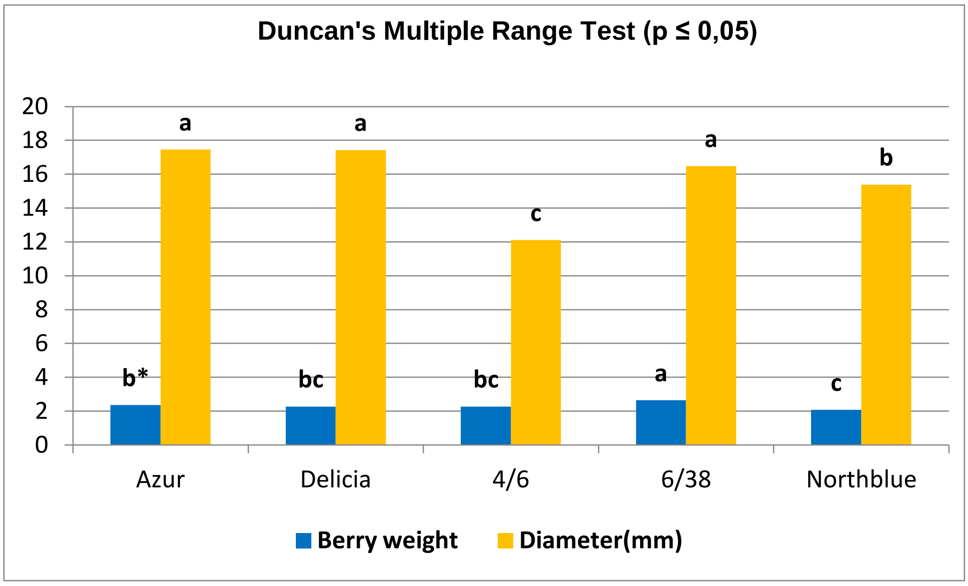


**Fig. 1. Variations in berry weight and diameter in blueberry fruits of genitors**

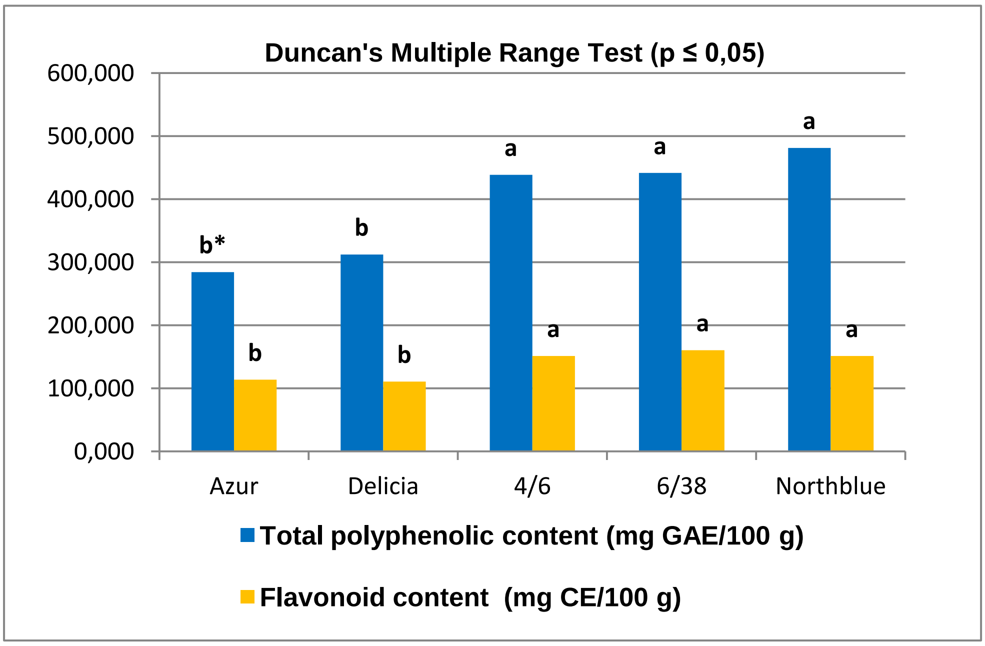


**Fig. 2. Variations in total polyphenolic and flavonoid content in blueberry fruits of genitors**

DOI 10.33045/fgr.v38.2022.33

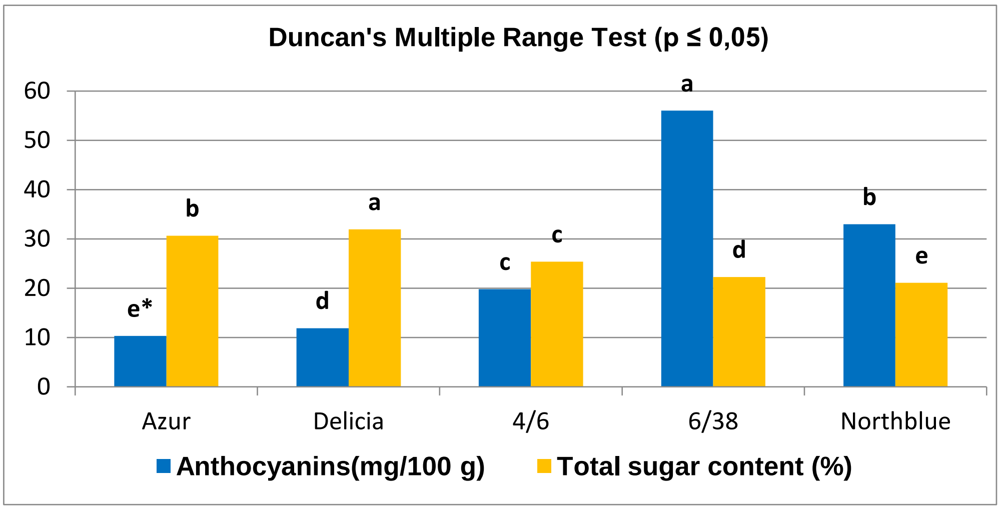


**Fig. 3. Variations in total anthocyanins and sugar content in blueberry fruits of genitors**

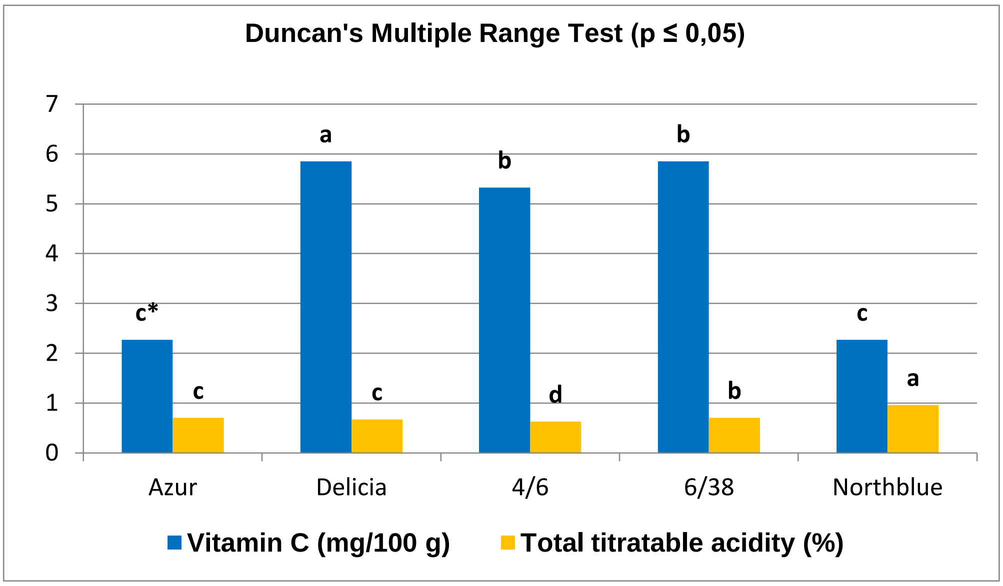


**Fig. 4. Variations in vitamin C content and total titratable acidity blueberry fruits of genitors**

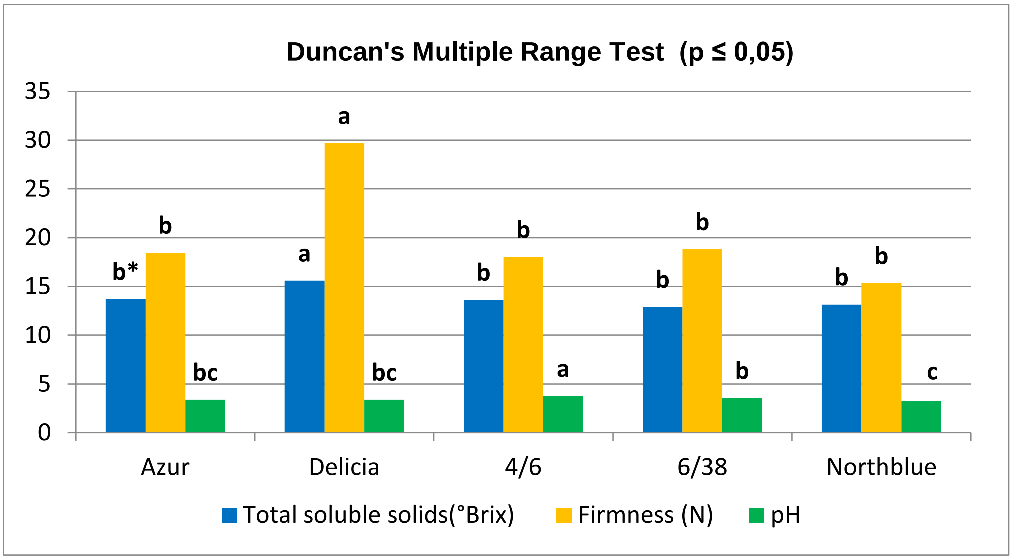


**Fig. 5. Variations in total soluble solids, firmness and pH blueberry fruits of genitors**

 DOI 10.33045/fgr.v38.2022.33

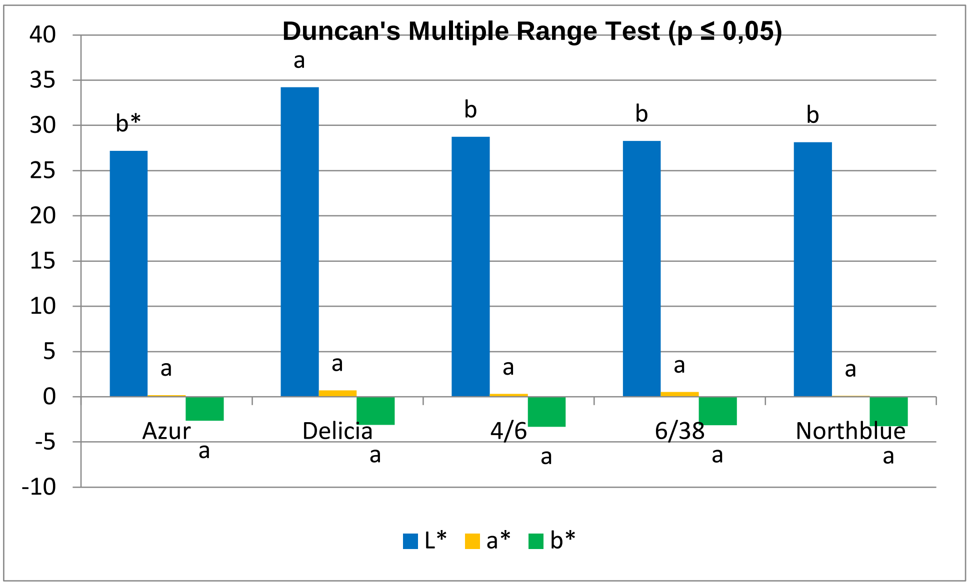


**Fig. 6. Variations in the external fruit color blueberry fruits of genitors**