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EVALUATION OF THE QUALITATIVE CHARACTERISTICS OF SOME NEW BLUEBERRY VARIETIES AT USAMV OF BUCHAREST

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Abstract

Cultivation of blueberries is of great importance nowadays due to the high antioxidant content of the fruits and for a healthy diet. Given the high demand for fruits on the domestic and foreign market, the use of fruits in current consumption and in the processing industry, the highbush blueberry (Vaccinium corymbosum L.), has become a species of interest both globally and in Romania in recent years. Therefore, there are currently numerous breeding programs, carried out in most countries with advanced fruit growing, based on specific breeding objectives aimed at creating new valuable blueberry varieties. In this paper, 17 blueberry varieties (Vaccinium corymbosum L.) from the Experimental Field of the Faculty of Horticulture in Bucharest were analysed, within the blueberry variety collection established in 2018. The results presented are important for farmers, providing them with the information they need to cultivate such varieties according to market preferences. The analysed varieties can be included as gene sources in the blueberry breeding program carried out at UASVM Bucharest.

Key words: *Vaccinium corymbosum L., biometric characteristics, biochemical characteristics*

INTRODUCTION

The cultivated blueberry is one of the species of berries that are of great interest to both growers and consumers. Blueberry cultivation is of great importance nowadays due to the high antioxidant content of the fruit and for a healthy diet (Edger et al., 2022; Asanica et al., 2017).

The high demand for fruit on the domestic and foreign market combined with the use of blueberry fruits for fresh consumption and processed drive the highbush blueberry (*Vaccinium corymbosum* L.) to become a species of interest both worldwide and in Romania in the recent years. The highbush blueberry stands out for its highly appreciated fruits for fresh consumption, having two to four times larger fruits than those of the wild blueberry (*Vaccinium myrtillus* L.) (Howell et al., 2001).

Blueberries are rich in bioactive anthocyanins, with high levels of malvidin, which is associated with antioxidant benefits that contribute to reducing the risk of diabetes (Herrera-Balandrano et al., 2021).

Blueberries have received much attention and are recommended as one of the five healthy fruits by the Food and Agriculture Organization, due to their beneficial effects on health, based on their antioxidant, anticancer, anti-inflammatory, antiseptic, antiproliferative, anti-aging, astringent, neuroprotective, cardio, vision and kidney protective properties and because they are a good source of fibre, vitamins (B, C and K), folic acid, fatty acids, polyphenols (anthocyanins) and minerals, such as Ca, Fe, K, Mg and Mn (Kuang et al., 2022; Banerjee et al., 2020; Kumar et al., 2022; Hakkinen &Toronen, 2000; Okan et al., 2018).

In a study conducted by Ojog el al., 2024, consumer preferences were presented regarding some of the fruit quality indicators (size, color, firmness, juiciness, taste and aroma) for 30 blueberry varieties, of which 8 were Romanian varieties. The most appreciated blueberry varieties were ‘Brigitta’, ‘Pink Lemonade’ and ‘Putte’, with high scores for almost all indicators, and the Romanian variety that ranked well was ‘Delicia’, especially for juiciness, firmness, colour and size.

This demonstrates how cultivars with stable fruit quality traits, such as firmness, may be more suitable for the retail market and much preferred by consumers (Hera et al., 2023; Hera, 2024).
There are currently numerous breeding programs, carried out in most countries with advanced fruit growing, based on specific breeding objectives aimed at developing new valuable blueberry cultivars (Song & Hancock, 2011; Popescu et al., 2021).
In Romania, the genetic improvement of blueberry to obtain new, productive varieties with large, aromatic fruits, resistance to winter frost remains a main objective in research programs. Fruit quality is specific to each variety and can be influenced by the way in which they are influenced by environmental conditions, applied cultivation technology, harvesting, transportation, cold storage, fruit packaging (Hancock, 2006; Forney et al., 2012). Apart from the commercial aspect, which is decisive for fruits dedicated for fresh consumption, an important role is played by the taste, but also by the other characteristic features of the fruits (average weight of a fruit, fruit firmness, ripening grouped in clusters, colour, aroma, consistency, etc.) (Kloet, 1980).
Starting with 2021, the University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Horticulture, started a blueberry breeding program, in addition to the general breeding objectives established for blueberries, specific objectives were targeted, such as: earliness, large fruit, variability of fruit colour and decorative appearance. Sixteen hybrid combinations were realised, resulting in 636 hybrid fruits (Asanica et al., 2021; Popescu et al., 2021). Currently, over 700 blueberry hybrids are under evaluation in the breeding field of the Faculty of Horticulture. Finally, given the great influence of environmental conditions on fruit quality, it is recommended that breeder's sample and examine fruits from advanced selections after several weeks of storage before releasing the variety (Sater et al., 2021).

MATERIALS AND METHODS

In this paper, 17 blueberry varieties (*Vaccinium corymbosum* L.) were analysed from the Experimental Field of the Faculty of Horticulture (Figure 1) in Bucharest, within the blueberry variety collection (Figure 2) established in 2018.

Figure 1. Experimental field of the Faculty of Horticulture

Figure 2. Collection of blueberry varieties

To evaluate the 17 blueberry varieties studied, determinations were made on the following quantitative and qualitative characteristics (Cociu & Oprea, 1989):

Biometric characteristics:
- the average fruit weight (g) was determined by weighing a sample of 20 fruits from the 5 plants/varieties using the PS Partner technical balance (in grams), after the picking, depending on the ripening period of each variety, calculating the average weight;
- the fruit dimensions (mm) was appreciated considering the height and equatorial diameter of each fruit measured with a digital calliper (mm);
- the shape index calculated according to the formula: height/diameter of the fruit;
- the fruit firmness (kgf/cm^2) was determined on a sample of 5 fruits/plant/varieties at each picking time using the Turoni TR penetrometer.

Biochemical characteristics of the fruits:
- the soluble dry matter (SUS) content (Brix%) of the fruits was determined by the refractometric method on a sample of 20 fruits from the 5 plants/varieties, with the Milwaukee MA871 digital refractometer;

- the fructose content (%) and glucose content (%) were determined, by the same method and on the same sample, using the Milwaukee MA884 and MA873 refractometers;
- the pH of the fruits was determined with the IQ Scientific digital pH meter, on average samples analysed at each harvest;
- total dry matter content (%) (SUT) determined using the UN110 Memmert oven, at a temperature of 105°C for 24 hours. The method consisted of blending the fruits until a homogeneous paste was formed, followed by weighing the initial tare. The next step consisted of weighing the trays filled with approximately 5g of sample. For each variety, two analysis samples were carried out and introduced into the oven. After 24 hours, the trays with the dehydrated samples were weighed and the SUT was calculated according to the formula:

Total dry matter (TDS) (%) = 100 – Moisture (%)
U% = (cp-cpu)/(cp-cg)*100
where:
U% = moisture %;
cg = empty zero weight;
cpu = zero weight with sample after drying;
cp = zero weight with sample before drying.

- total polyphenol content (TPC) (mgGAE/ 100 g) was determined using the Folin-Ciocalteu method, with a methanol solution of plant material, obtained by vortexing 1 g of plant material in 10 mL of 70% methanol in a Vortex Mixer VX-200 Corning-Labnet system. Absorbance was measured using a UV-VIS Specord 210 Plus spectrophotometer (Analytik Jena, Jena, Germany) at a wavelength of 760 nm;
- total titratable acidity (malic acid/100 g) was determined using an extract of plant material, to which 25 ml of distilled water was added, the initial pH value was measured, and then titrated with 0.1N NaOH until the pH reached 8.1, using the TitroLine Easy automatic titrator (SI Analytics GmbH, Germany). TTA results were expressed in grams of citric acid per 100 grams of fresh fruit. Total titratable acidity was expressed as a percentage of malic acid. Results were calculated using the formula:

Titratable acidity = ml NaOH 0.1N * 100 * 0.0067/sample mass

- antioxidant activity (mg equal Trolox/100 g fresh sample) was performed by the DPPH (2,2-diphenyl-1-picrylhydrazyl) method, similar to that described by Petre et al. (2022): 0.2 ml of extract are mixed with 2 ml of 0.2 mM DPPH solution in 100% methanol and incubated in the dark for 30 minutes, with homogenization. The absorbance of the samples is measured at a wavelength of 515 nm. The solution used as reference was 100% methanol.

Data interpretation

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.

RESULTS AND DISCUSSIONS

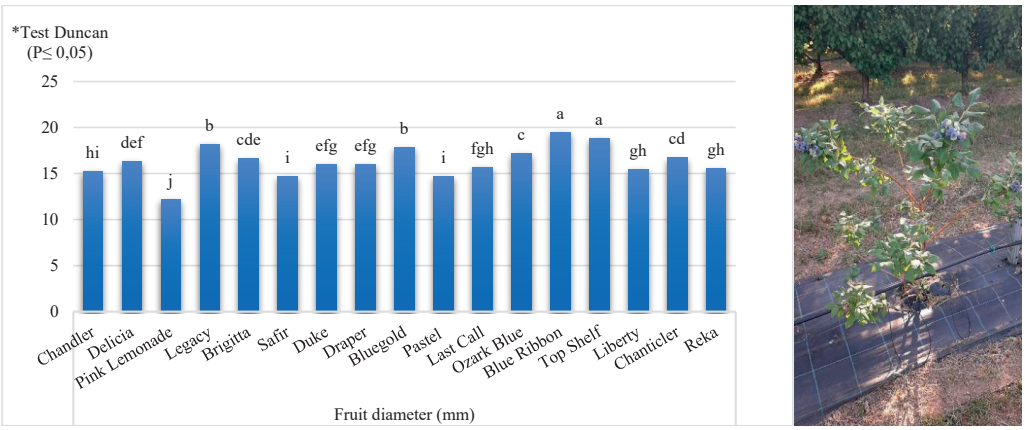
Biometric characteristics

The main biometric characteristics of blueberry fruit refer to the size, shape and texture of the pulp and are expressed by: fruit diameter, shape index, average weight and firmness.

Statistical analysis performed by univariate ANOVA demonstrated that there are significant differences between the studied varieties in terms of average fruit diameter ($p < 0.05$). The variety 'Pink Lemonade' has the smallest fruits (12.20 mm), significantly different from all other varieties.

The varieties 'Duke', 'Draper' and 'Delicia' have diameters around 16.0-16.3 mm, being in the median groups, with no significant differences between them.

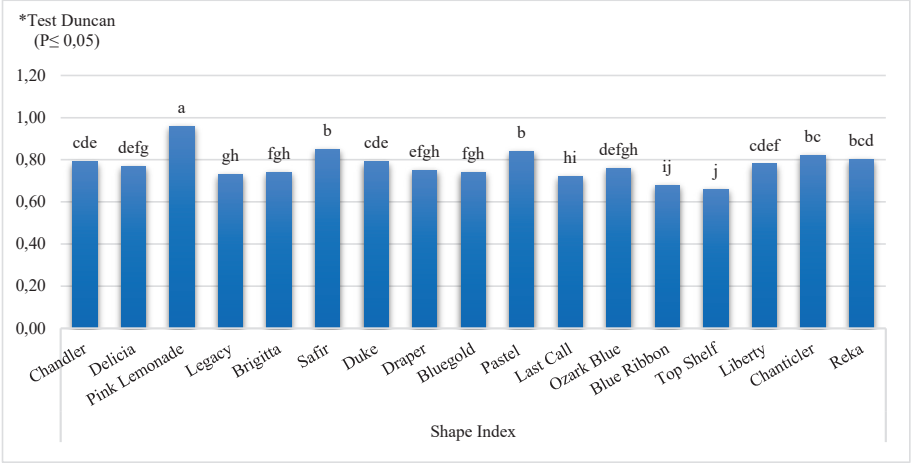
The highest diameter was measured in: 'Blue Ribbon' (19.5 mm), significantly larger than most of the analysed varieties (Figure 3), falling into the premium category, with a significantly higher price.



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 3. Variation in fruit diameter in cultivated blueberry

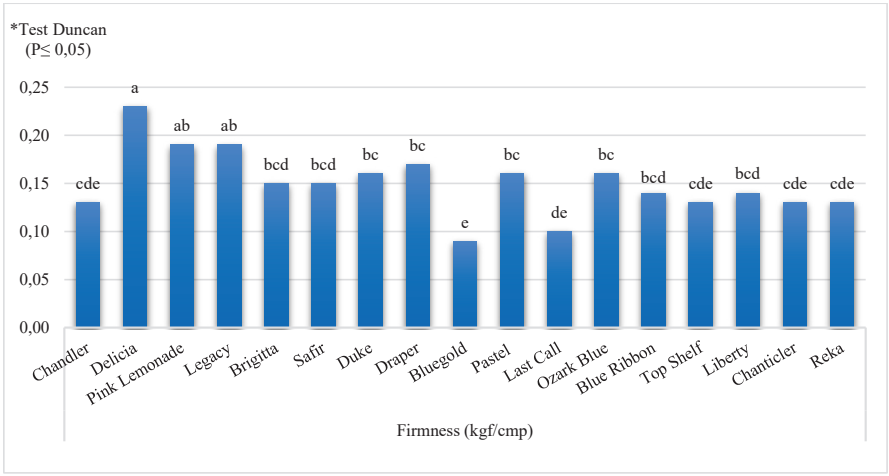
The shape index expresses the ratio between the longitudinal and transversal diameter of the fruit - higher values above 1 indicate more elongated fruits, values close to 1 indicate spherical fruits, and below 1 indicate flattened fruits. 'Top Shelf' (0.66) and 'Blue Ribbon' (0.68) are the most flattened, very significant differences compared to the rest of the varieties, recorded by the variety 'Pink Lemonade' (0.96) which stands out statistically from all the other varieties (Figure 4).



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 4. Variation in fruit shape index in cultivated blueberry

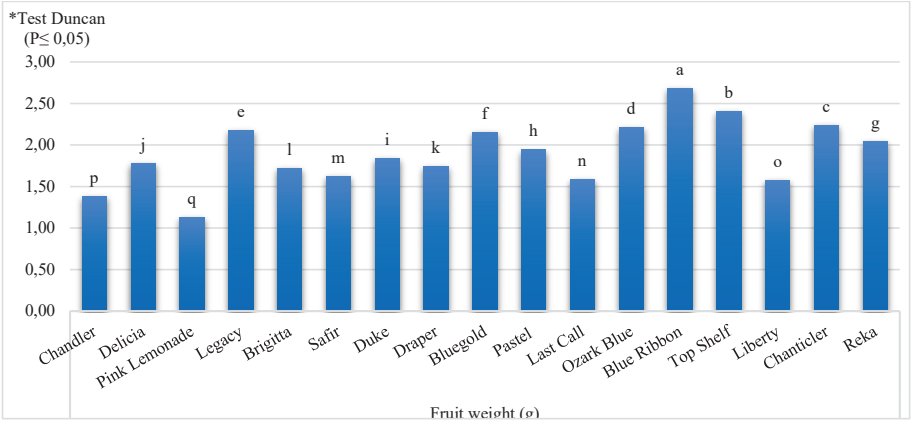
Varieties with high firmness are more suitable in this respect for mechanized harvesting and sale over longer distances. The processed data show significant differences between the studied varieties. The varieties 'Pink Lemonade', 'Legacy' and 'Delicia', with the index between 0.19-0.23, have a special resistance for the post-harvest segment (Figure 5), excellent for export and storage.



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 5. Variation in fruit firmness in cultivated blueberries

The average fruit weight differs significantly between varieties ($p < 0.05$), demonstrating the determining influence of the variety. 'Blue Ribbon', 'Top Shelf' and 'Chanticler' have a superior commercial value, recommended for export and the premium market. The highest average fruit weight was recorded by the variety 'Blue Ribbon' (2.68 g), and the lowest by the variety 'Pink Lemonade' (1.13 g), but it charms in terms of colour, a wonderful shade of dark, intense pink, extremely attractive and sweet taste (Figure 6).

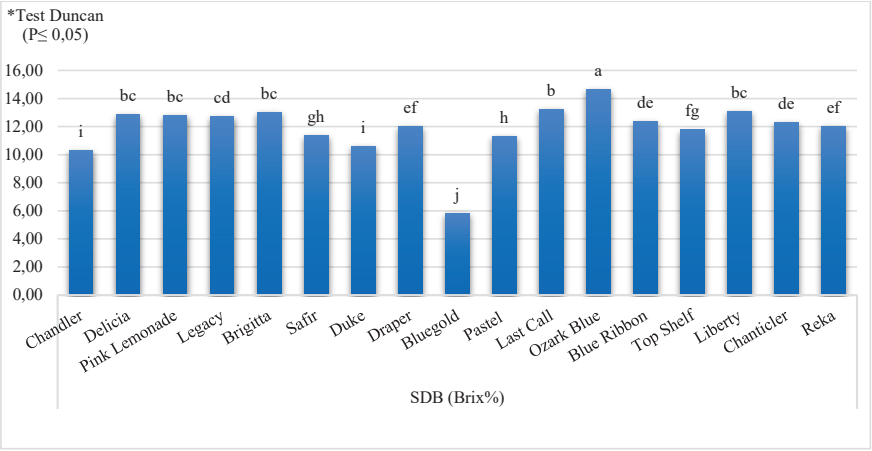


*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 6. Fruit weight variation in cultivated blueberry

Biochemical characteristics

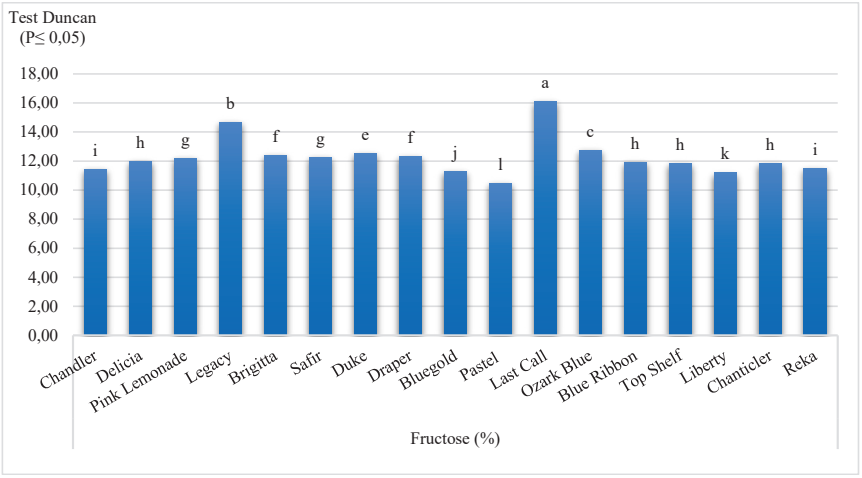
The soluble dry matter (SUS) content (Brix) level ranged between 5.83 ('Bluegold') and 14.66 ('Ozark Blue'), the sugar accumulated in the fruit being genetically determined, influenced by the intensity of photosynthesis and the physiological ripening specific to the variety. At the same time, the sweet taste attracts consumers, the varieties with values >12 °Brix ('Chanticler', 'Blue Ribbon', 'Legacy', 'Pink Lemonade', 'Delicia', 'Brigitta', 'Liberty', 'Last Call' and 'Ozark Blue') being recommended for fresh consumption (Figure 7).



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 7. Variation in soluble dry matter content of cultivated blueberry fruits

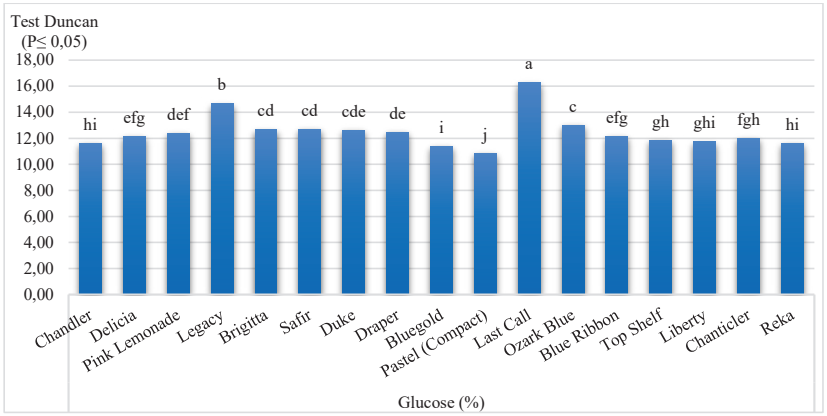
The analysis of the variable fructose content (%) shows that the variety significantly influences the accumulation of fructose in the fruit (Figure 8), with values ranging between 10.44% in the 'Pastel' variety, with minimal content and a less sweet taste, and 16.08 in the 'Last Call' variety, which is statistically distinguished by the highest degree of fructose accumulation.



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 8. Variation in fructose content of cultivated blueberry fruits

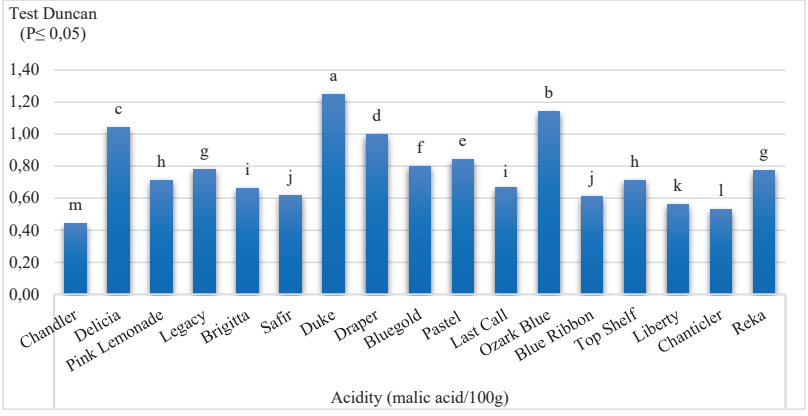
Concerning glucose content, the data obtained group the values in 10 classes, indicating consistent variations between varieties, with 'Last Call' having the highest content (16.26 mg/100 g), significantly different from most varieties (Figure 9).



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 9. Variation in glucose content of cultivated blueberry fruits

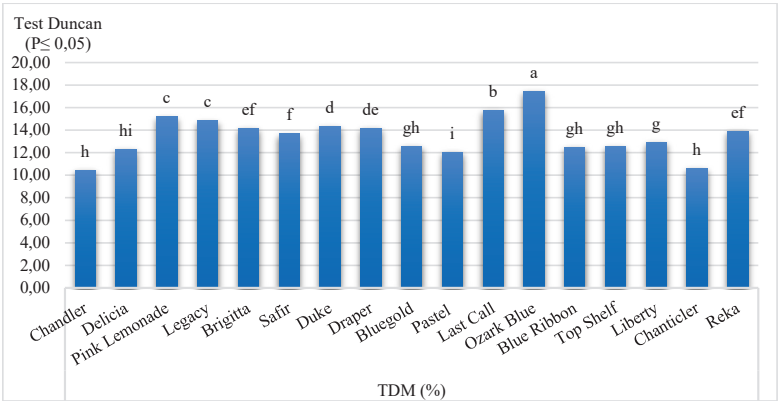
Acidity is a major indicator of freshness, oxidative stability, and shelf life. Varieties with high acidity are more resistant to post-harvest degradation and are more suitable for processing (juices, jams, freezing), while those with lower acidity are preferred by consumers looking for sweet fruits. The cultivar 'Duke' recorded the highest content of 1.25 malic acid/100 g, at statistically significant differences compared to the other cultivars, followed by the cultivar 'Ozark Blue' with 1.14 malic acid/100 g (Figure 10).



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 10. Variation in titratable acidity of cultivated blueberry fruits

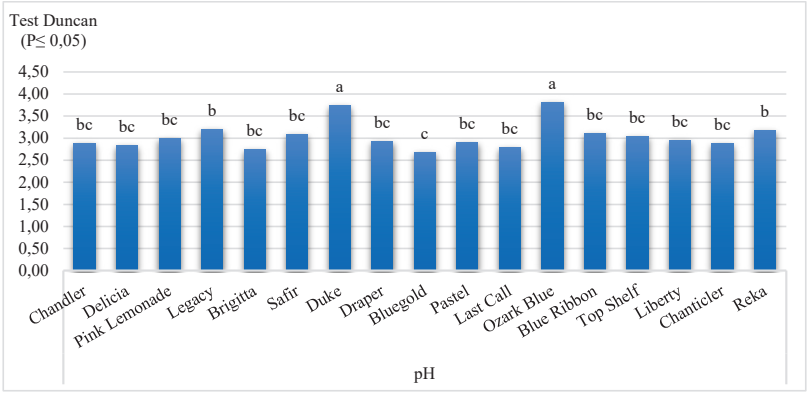
The soluble dry matter content - a cumulative indicator of sweetness and nutritional-energy potential, essential in breeding, was recorded by the varieties 'Ozark Blue' (17.43), 'Last Call' (15.76) and 'Pink Lemonade' (15.17) with the highest values (Figure 11).



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 11. Variation in total dry matter content of fruits in cultivated blueberry

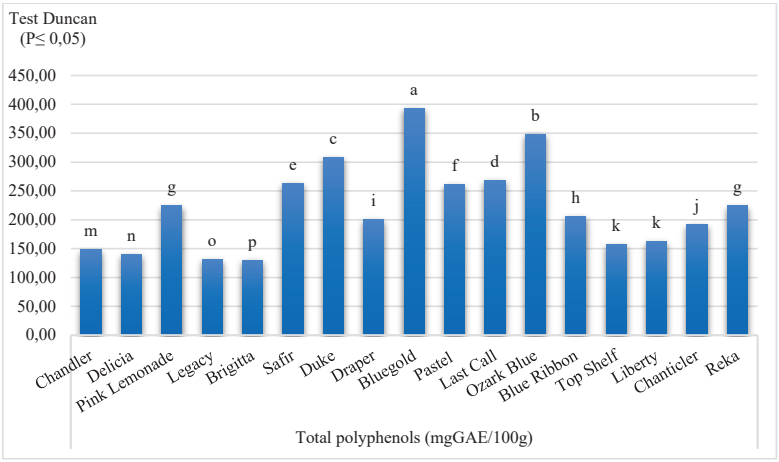
The analysis of the pH variable (the expression of acidity in the fruit pulp) indicates a moderate genetic variability, dividing the analysed varieties into 3 distinct groups, some with low pH (more acidic), moderate and high (less acidic). The first group includes the varieties 'Bluegold', 'Brigitta', 'Last Call', 'Delicia', 'Chanticler', 'Chandler', 'Pastel', 'Draper' with a content between 2.68-2.91. At moderate pH 2.95-3.20 are the varieties 'Liberty', 'Pink Lemonade', 'Top Shelf', 'Safir', 'Blue Ribbon', 'Reka', 'Legacy' which provide a sweet-sour balance, preferred for fresh consumption. The least acidic varieties are 'Duke' with pH 3.75 and 'Ozark Blue' with pH 3.81 (Figure 12).



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 12. Variation in fruit pH in cultivated blueberries

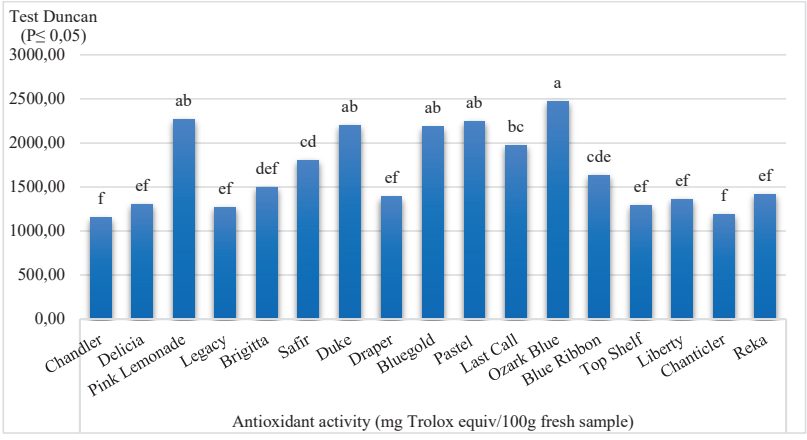
Polyphenols are one of the most important bioactive components of blueberries, contributing to their high antioxidant capacity, cardiovascular and neuroprotective protection, intense colour (through anthocyanins) and greater resistance to handling and storage. The varieties 'Brigitta' (129.77) and 'Legacy' (131.02) recorded the highest low values of total polyphenol content (mg GAE/100 g), they are suitable for fresh consumption (Figure 13). Recommended in functional nutrition, for supplements with therapeutic value, the varieties with content over 300 mg GAE/100 g are noted: 'Duke' (308.33), 'Ozark Blue' (347.6) and 'Bluegold' (393.02).



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 13. Variation in total polyphenol content of cultivated blueberry fruits

Antioxidant capacity reflects the ability of bioactive compounds (especially polyphenols and anthocyanins) to neutralize free radicals - a key indicator of the therapeutic and nutritional potential of blueberries. The highest values were recorded in the varieties 'Ozark Blue' (2475.84), 'Pastel' (2248.42), 'Pink Lemonade' (2270.11), 'Duke' (2202.31) and 'Bluegold' (2181.88), which are classified as resources with high nutraceutical potential, recommended for functional food products and antioxidant supplements (Figure 14).



*Duncan test. Mean values with the same letter do not show significant differences (P≤0.05)

Figure 14. Variation in antioxidant capacity of cultivated blueberry fruits

CONCLUSIONS

The results are important for farmers, providing them the key supportive data for decision regarding choosing the proper blueberry varieties according to market preferences. The analysed varieties can be included as gene sources in the blueberry breeding program carried out at USAMV of Bucharest, towards obtaining new varieties with a large quantity of bioactive compounds in close correlation with the variety-specific phenotypic plasticity in response to gradual changes in environmental conditions from Romania.

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