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MINERAL COMPOSITION, NUTRITIONAL AND FUNCTIONAL VALUE OF SOME NEW BLUEBERRY VARIETIES AT USAMV OF BUCHAREST

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Abstract

The purpose of this study was to evaluate the mineral and biochemical composition of fruits from 17 cultivated blueberry varieties (Vaccinium corymbosum L.), grown under the pedoclimatic conditions specific to the Bucharest area. The biological material analyzed included varieties of horticultural importance, and the determinations targeted macroelements (Mg, P, K, Ca), microelements (Mn, Fe, Zn, Cu, Al), as well as protein and oil content. The results confirm that the 17 analyzed varieties largely fall within the parameters specific to cultivated blueberries, demonstrating good agronomic adaptation and appropriate nutritional quality. The identified deviations are limited and can be explained by genetic variability and environmental conditions, without indicating major imbalances. Overall, the mineral and biochemical profile of the studied varieties is representative of the species Vaccinium corymbosum L. and confirms their value for both consumption and processing. The 'Duke', 'Legacy'and 'Blue Ribbon' cultivars stood out due to their superior mineral and biochemical profiles and are recommended for producing fruits with high nutritional value under the conditions of the Bucharest area.

Key words*: Vaccinium corymbosum L., cultivar, micro and macronutrients, proteins, lipids.*

INTRODUCTION

Cultivated blueberry (*Vaccinium corymbosum* L.) is one of the most important berry species grown worldwide, valued both for its organoleptic properties and its high nutritional value. It is considered a horticultural crop of significant economic importance, with multiple benefits for human health (Liu et al., 2025).

The mineral and nutritional composition of blueberry fruits can vary considerably depending on several factors, including the cultivated variety, pedoclimatic conditions, soil type, level of fertilization, and stage of fruit maturity. Genetic differences among cultivars can lead to significant variations in mineral element concentrations, as highlighted in numerous studies on the nutritional diversity of cultivated blueberries (Dróżdż et al., 2017; Krishna et al., 2023; Lachowicz-Wiśniewska et al., 2024; Bujor et al., 2025).

Although blueberries are not a major source of proteins or fats in the diet, they contribute to overall nutrient intake and are considered functional foods due to their high content of bioactive compounds and antioxidants. Regular consumption of blueberries is associated with multiple health benefits, including antioxidant, anti-inflammatory, and cardioprotective effects (Kalt et al., 2019).

Blueberry fruits are characterized by a complex chemical composition that includes carbohydrates, dietary fiber, vitamins, minerals, phenolic compounds, and small amounts of proteins and lipids. In recent years, researchers' interest in analyzing the biochemical composition of blueberries has increased significantly due to the role of these nutrients in human nutrition and in the development of functional food products (Rashwan et al., 2024). In addition to their high antioxidant content, these fruits are also an important source of macro- and microelements essential for human metabolism. Among the mineral elements present in blueberries, potassium, calcium, magnesium, and phosphorus stand out as essential macroelements for proper body function. In smaller amounts, but with important biological roles, microelements such as iron, manganese, zinc, and copper are also

present, participating in numerous metabolic and enzymatic processes (Lachowicz-Wiśniewska et al., 2024; Cabrera et al., 2021).
Potassium is considered one of the most abundant mineral elements in blueberry fruits, playing an important role in maintaining electrolyte balance and regulating cardiovascular functions. Calcium and magnesium are also important mineral components of blueberries. Calcium contributes to the structural stability of plant tissues and influences fruit firmness, while magnesium is involved in numerous enzymatic reactions related to plant and human metabolism (Aşık et al., 2019).
Among microelements, manganese is of particular importance, being involved in the activity of antioxidant enzymes and in carbohydrate and lipid metabolism. Studies show that blueberries can be considered a valuable source of manganese, as well as iron and copper, elements involved in oxygen transport processes and immune system function (Cabrera et al., 2021). Some research indicates that wild blueberries may exhibit higher levels of certain minerals compared to cultivated ones, with differences influenced by environmental conditions and the genetic characteristics of species within the *Vaccinium* genus (Negrusier et al., 2024).
Some studies on the chemical composition of blueberries have shown that protein and lipid levels can vary significantly among different parts of the fruit, such as the skin, pulp, and seeds. Analyses of these components indicate that seeds contain higher concentrations of lipids and proteins compared to the fruit pulp (Li et al., 2023). Blueberry fruits contain relatively small amounts of proteins and fats compared to other plant-based foods; however, these components contribute to the overall nutritional value of the fruit (Ashique et al., 2024).
Regarding lipid content, blueberries are considered fruits with a very low fat content. Most lipids are located in the seeds and are mainly represented by unsaturated fatty acids (Uribe et al., 2024).
In this context, analyzing the chemical composition of blueberries, including protein and lipid content, is an important aspect for evaluating the nutritional value of the fruits and for characterizing different cultivars grown in the Bucharest cultivation area.

MATERIALS AND METHODS

In this paper, 17 blueberry varieties (*Vaccinium corymbosum* L.) from the Experimental Field of the Faculty of Horticulture in Bucharest were analyzed within the blueberry variety collection established in 2018 (Bujor et al., 2025). To evaluate the 17 studied varieties, determinations were carried out for the following qualitative characteristics: micro- and macronutrient analysis, determination of total nitrogen content, determination of protein content, and determination of lipid content. For the purpose of comparing the studied elements across the 17 analyzed varieties (Table 1). presents the reference ranges reported in the scientific literature for cultivated blueberry (*Vaccinium corymbosum* L.).

Micro and macronutrients analysis
The fresh blueberry samples were ground, and three samples were subjected to microwave extraction as follows: 0.250 g, 8 mL HNO_3 and 2 mL H_2O_2. The control consisted of 8 mL HNO_3 and 2 mL H_2O_2. The samples were subjected to 725 ICP-MS analysis Agilent 7700X (Bashdar & Rasul, 2023; Constantin et al., 2023; Barbu et al., 2023). The analysis was carried out based on the calibration curve of the multi-element standard Agilent Technologies solution.
Determination of total nitrogen content - *Dry combustion method (Dumas method)*
The development and validation of the analytical method were performed using an automated CHNS elemental analyzer (Eurovector EA 3100) with the following accessories: - Eurovector CHN combustion tube for 250 sample analyses of C, N, and H; - double autosampler (carousel) with 40+40 positions; - Mettler Toledo microbalance (precision 0,000001 g); - H2O trap for water elimination; - PTFE GC column, outer diameter 8 mm, length 2 m; - Weaver.NET 1.8.0.0 software.
The determination of total nitrogen content was carried out using the Dumas method, employing the Eurovector EA 3100 elemental analyzer. This method involves the complete

combustion of dried and ground samples at high temperatures in an oxygen atmosphere. The nitrogen oxides formed are reduced to molecular nitrogen (N_2), which is subsequently separated and quantified using a thermal conductivity detector (TCD). The results were expressed as a percentage of nitrogen relative to the dry weight of the sample (Mot et al., 2022).

Determination of protein content

The determination of protein content was carried out indirectly, based on the total nitrogen content determined by the Dumas method. The resulting nitrogen value was quantified and converted into protein content by applying the general conversion factor of 6.25 (Barbu et al., 2023; Constantin et al., 2023).

Determination of lipid content - Soxhlet method

Lipid content was determined by Soxhlet extraction, using an organic solvent (such as petroleum ether or hexane) under continuous reflux over the dried and ground sample. After solvent evaporation, the lipid residue was weighed, and the results were expressed as a percentage of fat relative to the sample mass.

Natural (physico-geographical) conditions of the research area

The Municipality of Bucharest is located in the Vlăsia Plain, the central subdivision of the Romanian Plain has altitudes ranging from 100-115 m in the northwest to 50-60 m in the southeast, in the Dâmbovița floodplain. The climate is temperate-continental, characterized by moderate thermal extremes caused by high urban density, heavy traffic, and industrial activities. While the annual mean temperature is 10.7°C in peripheral areas, the central zone records an average of 12°C.

Soil pedological and agrochemical characterization

The predominant soil in the study area is a reddish preluvosol, characterized by a low humus content of 2.5%, a loam-clay texture, a pH of 6.2, and low to medium nutrient supply (N, P, K). Blueberry requires medium-textured, well-drained soils without gleiing to a depth of 40-50 cm and with an acidic reaction. The optimal soil pH range is between 4.5 and 5.2. Lowering soil pH before planting by adding acidic peat is essential.

RESULTS AND DISCUSSIONS

Table 1 presents the reference ranges reported in the scientific literature for *Vaccinium corymbosum* L. and the content of the 17 blueberry varieties studied.

Table 1. Limits of mineral element content in the 17 cultivated blueberry varieties vs. reference values from the scientific literature (*Vaccinium corymbosum* L.)

Element	Obtained value (min.-max.)	Literature reference
Macroelements (mg/100 g)		
Mg	4.81-7.52	5.0-8.0
P	6.66-17.22	7.0-20.0
K	66.76-93.14	70-90
Ca	6.22-10.02	6-9
Microelements (mg/100 g)		
Mn	0.31-0.44	0.2-0.5
Fe	0.17-0.29	0.2-0.4
Zn	0.14-0.30	0.1-0.3
Cu	0.06-0.29	0.05-0.2
Al	0.25-1.02	0.1-1.5
Organic compounds (g/100 g)		
Proteins	0.38-0.91	0.4-0.7
Lipids	0.30-0.58	0.3-0.5

Micro and macronutrients

The fruits of cultivated blueberry (*Vaccinium corymbosum* L.) are characterized by a diverse chemical composition, which includes carbohydrates, dietary fiber, organic acids, vitamins, phenolic compounds, and mineral elements.

Micronutrients

The manganese (Mn) content varies within a narrow range (0.31-0.44 mg/100 g) (Figure 1), with all varieties falling within the reference ranges reported in the scientific literature for cultivated blueberry (*Vaccinium corymbosum* L.) (0.2-0.5 mg/100 g) (Table 1). This uniformity indicates stable physiological regulation and a balanced uptake of this microelement. Considering the role of manganese in activating enzymes involved in photosynthesis and metabolism, the lack of significant variation suggests good adaptation of all varieties to the cultivation conditions.

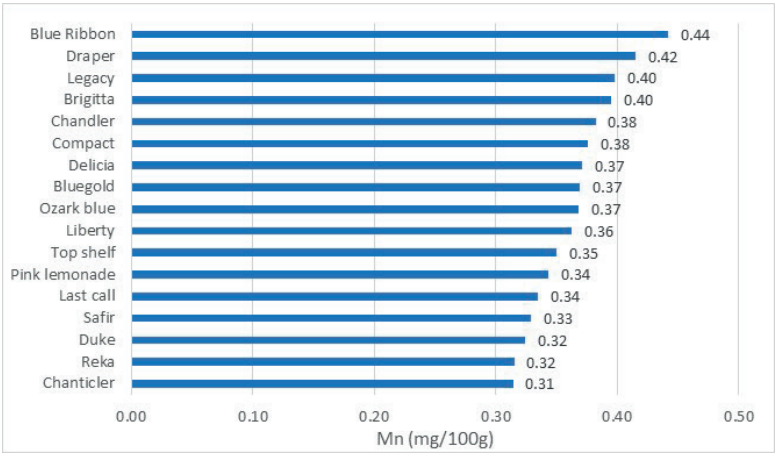

Figure 1. Variation of manganese (Mn) content in cultivated blueberry fruits

Iron (Fe) is present in concentrations ranging between 0.17 and 0.29 mg/100 g (Figure 2), with most values falling within the optimal range (0.2-0.4 mg/100 g) (Table 1). The 'Draper' variety shows the highest value (0.29 mg/100 g), while 'Delicia' (0.17 mg/100 g) is slightly below the lower limit. The variability is moderate and reflects differences in iron absorption and transport, an element essential for chlorophyll synthesis and redox processes. Overall, the iron content contributes positively to the nutritional value of the fruits.

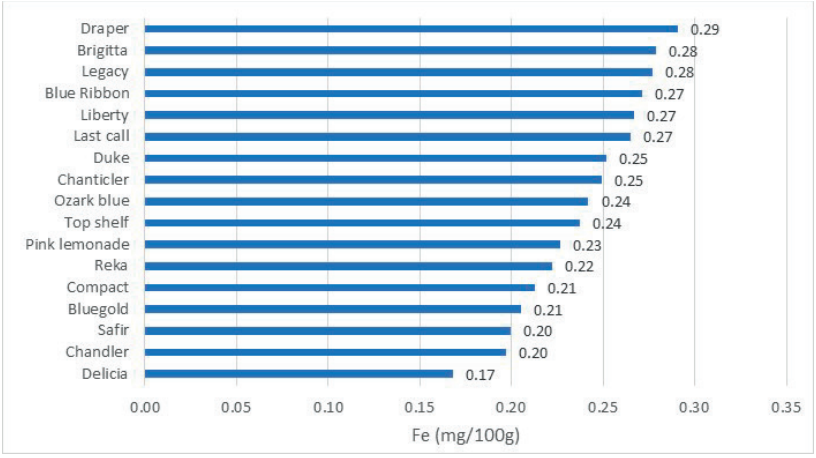

Figure 2. Variation of iron (Fe) content in cultivated blueberry fruits

Zinc (Zn) content ranges between 0.14 and 0.30 mg/100 g (Figure 3), highlighting moderate variability among the varieties. Most values fall within the optimal range (0.1-0.30 mg/100 g) (Table 1), indicating adequate mineral nutrition and good physiological balance. The 'Chandler', 'Delicia', and 'Pink Lemonade' varieties show the lowest concentrations, situated in the lower part of the range, while 'Reka' reaches the upper limit (0.30 mg/100 g). Overall, the distribution of values indicates that zinc is well regulated in most varieties, without major deviations, and the observed differences are most likely genetically determined, with a possible contribution from edaphic factors.

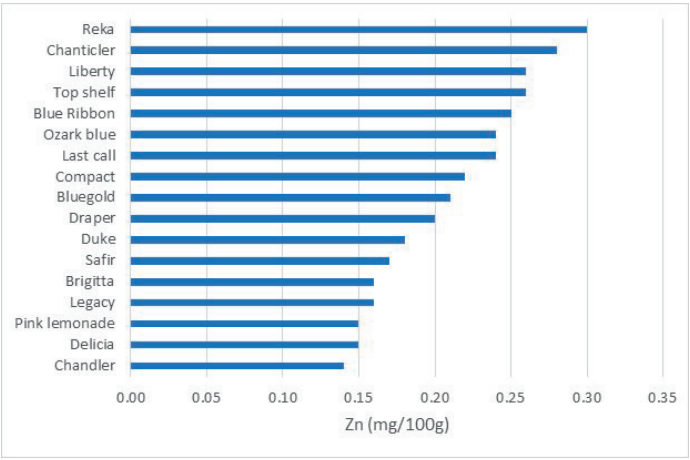

Figure 3. Variation of zinc (Zn) content in cultivated blueberry fruits

Aluminum (Al) content shows high variability, ranging between 0.25 and 1.06 mg/100 g (Figure 4). The 'Brigitta' (1.06 mg/100 g) and 'Legacy' (1.04 mg/100 g) varieties stand out with significantly higher values, while 'Draper' records the lowest concentration (0.25 mg/100 g), remaining above the minimum value of the reference range (0.1-1.5 mg/100 g) (Table 1). This wide dispersion suggests a strong influence of edaphic conditions, particularly soil acidity, as well as genetic differences in accumulation capacity.

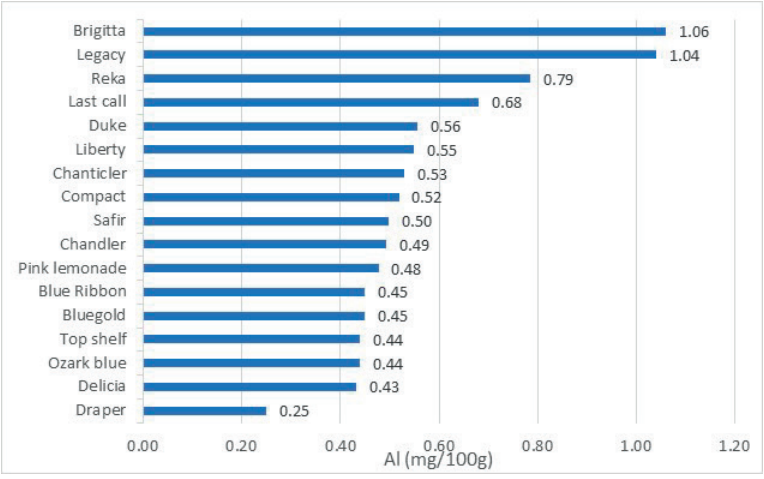

Figure 4. Variation of aluminum (Al) content in cultivated blueberry fruits

Copper (Cu) content shows relatively high variability (0.06-0.29 mg/100 g) (Figure 5) compared to the other microelements, being slightly higher in range. The 'Duke' variety stands out with a high value (0.29 mg/100 g), while 'Ozark Blue' records the lowest concentration (0.06 mg/100 g). Most varieties are clustered around the reference value of 0.1 mg/100 g (0.05-0.20 mg/100 g) (Table 1). The observed differences reflect genetic particularities and possible soil influences, considering the role of copper in enzymatic reactions and oxidative processes.

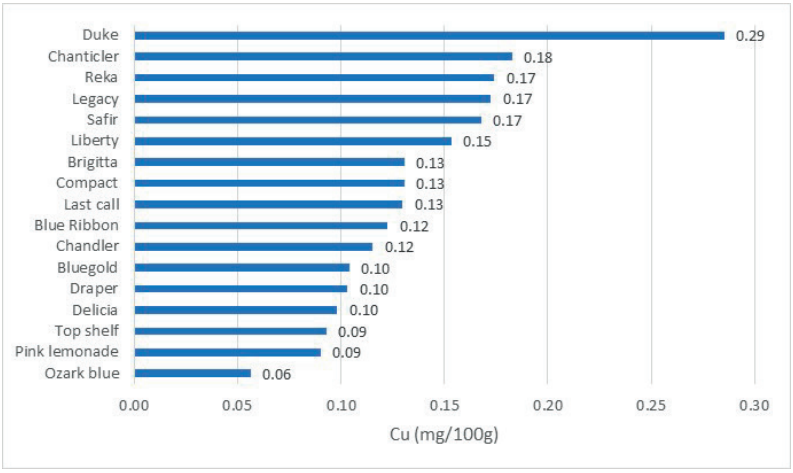

Figure 5. Variation of copper (Cu) content in cultivated blueberry fruits

Macronutrients

Magnesium (Mg) content ranges between 4.81 and 7.52 mg/100 g (Figure 6), showing relatively low variability among the varieties. Most values fall within the optimal range (5.00-7.00 mg/100 g), suggesting good physiological regulation of this essential macroelement (Table 1). The 'Blue Ribbon' (4.81 mg/100 g) and 'Ozark Blue' (4.99 mg/100 g) varieties show values slightly below the lower limit, while 'Duke' (7.52 mg/100 g) slightly exceeds the upper limit.

The relatively uniform distribution indicates that magnesium, a central component of the chlorophyll molecule, is metabolically stable, and the observed differences are minor, likely determined by genetic traits or soil availability.

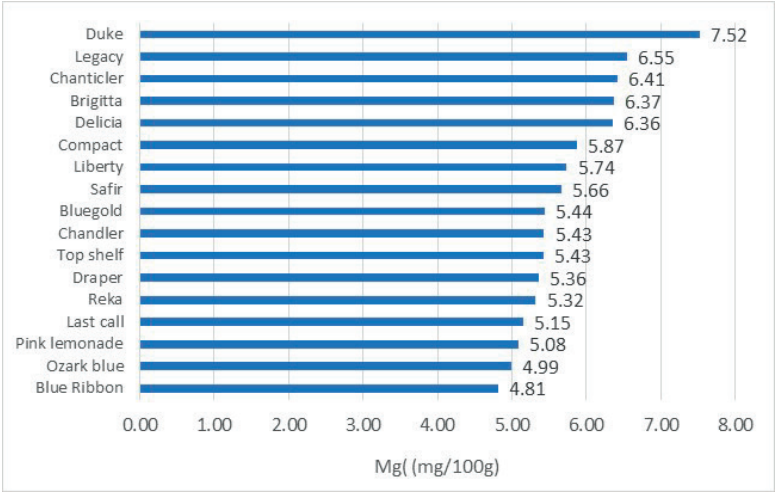

Figure 6. Variation of magnesium (Mg) content in cultivated blueberry fruits

The phosphorus (P) content in the 17 cultivated blueberry (*Vaccinium corymbosum* L.) varieties ranges between 6.66 and 17.22 mg/100 g (Figure 7), with most varieties falling within the optimal range reported in the scientific literature (7.00-20.00 mg/100 g) (Table 1). The 'Duke' (12.55 mg/100 g), 'Legacy' (14.66 mg/100 g), and 'Safir' (17.22 mg/100 g) varieties show high values, indicating strong metabolic potential and increased efficiency in energy-related processes. The 'Bluegold' variety is the only one slightly below the lower

limit. Overall, the distribution of values suggests an adequate phosphorus supply, essential for ATP synthesis and for fruit growth and maturation processes.

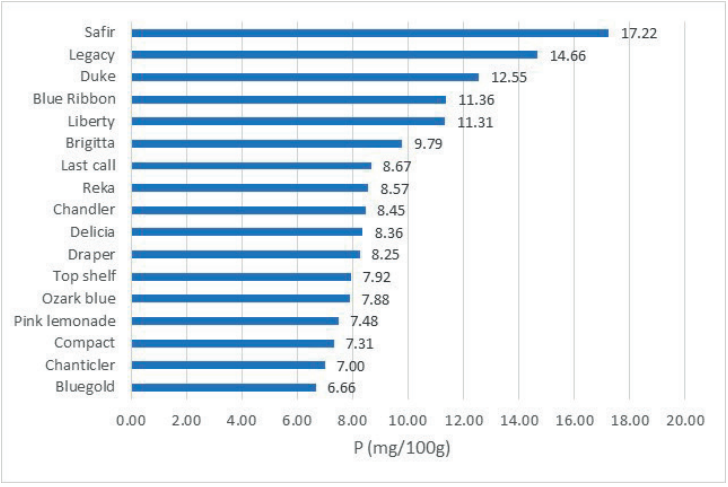

Figure 7. Variation of phosphorus (P) content in cultivated blueberry fruits

Potassium (K) content in the 17 cultivated blueberry (*Vaccinium corymbosum* L.) varieties ranges within a relatively wide interval (66.76-93.14 mg/100 g) (Figure 8), reflecting moderate to high variability among the varieties. Most values fall within the optimal range (70-90 mg/100 g) (Table 1); however, the 'Blue Ribbon', 'Pink Lemonade', and 'Delicia' varieties show values below the lower limit, while 'Ozark Blue' (93.14 mg/ 100 g) exceeds the upper limit.

Considering the role of potassium in regulating osmotic balance and sugar accumulation, these differences may directly influence the sensory quality of the fruits, with varieties showing higher values potentially being sweeter and juicier.

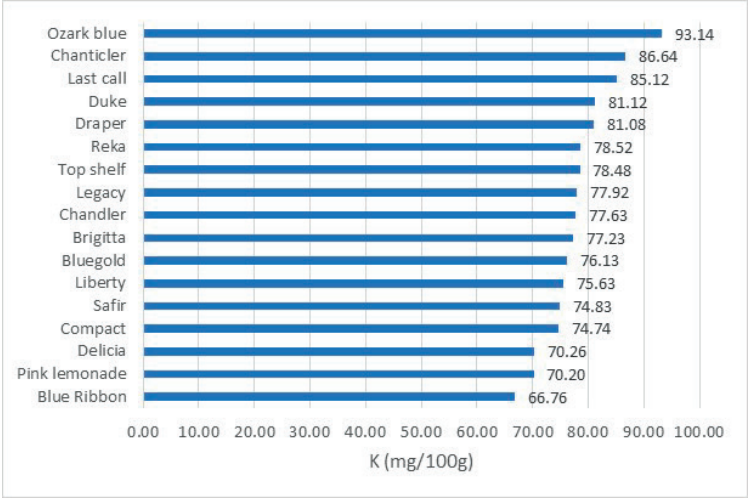

Figure 8. Variation of potassium (K) content in cultivated blueberry fruits

Calcium (Ca) content ranges between 6.22 and 10.02 mg/100 g (Figure 9), with most varieties falling within the optimal range (6.00-9.00 mg/100 g) (Table 1). The 'Brigitta', 'Liberty',

'Chanticleer', and 'Ozark Blue' varieties exceed the upper limit, indicating a higher accumulation of this element. Calcium is essential for the integrity of cell walls, and higher values may be associated with increased fruit firmness and better resistance to handling and storage.

The distribution of values suggests important varietal differences in the capacity for calcium accumulation.

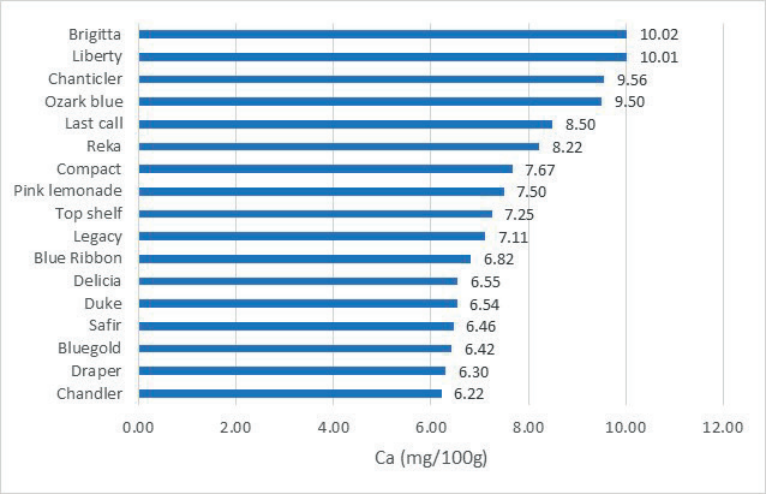

Figure 9. Variation of calcium (Ca) content in cultivated blueberry fruits

Protein content ranges between 0.38 and 0.91 g/100 g (Figure 10), with most varieties falling within the optimal range (0.4-0.7 g/100 g) (Table 1). The 'Duke' (0.65 g/100 g) and 'Legacy' (0.63 g/100 g) varieties are close to the optimal limits, while 'Blue Ribbon' (0.91 g/100 g) shows a significantly higher value compared to the others.

This distribution confirms that blueberries are not a major source of protein, and the observed variations are mainly of genetic origin.

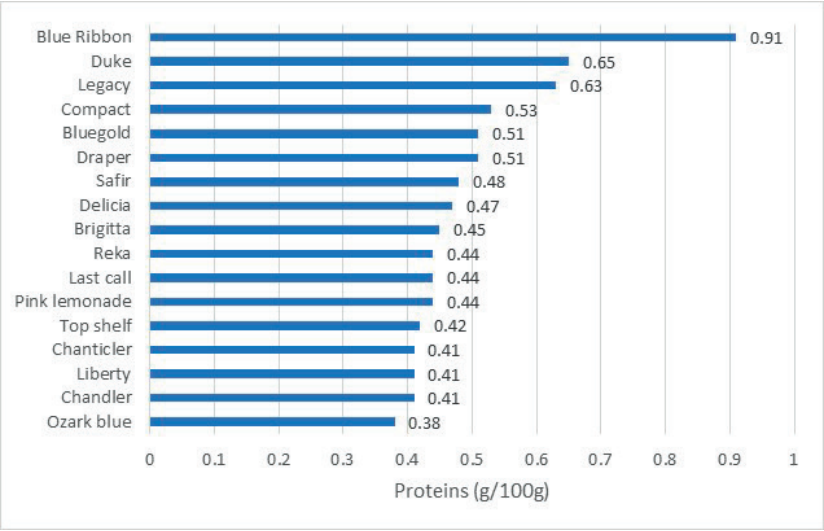

Figure 10. Variation of protein content in cultivated blueberry fruits

Lipid content ranges between 0.30 and 0.58 g/100 g (Figure 11), with most varieties falling within the optimal range (0.3-0.5 g/ 100 g) (Table 1). The 'Duke' variety (0.58 g/100 g) slightly exceeds the upper limit, while other varieties such as 'Top Shelf' (0.50 g/100 g) and 'Blue Ribbon' (0.48 g/100 g) show values close to this limit.

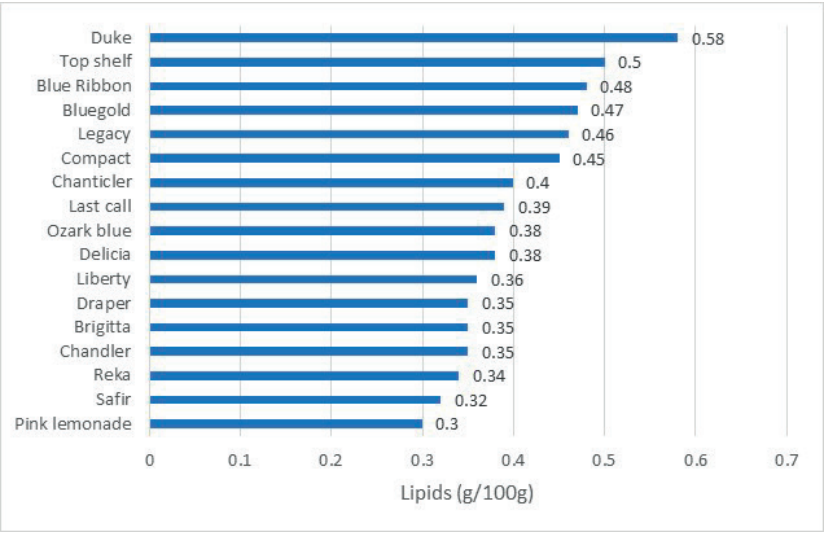

Figure 11. Variation of lipid content in cultivated blueberry fruits

CONCLUSIONS

The fruits of cultivated blueberry (*Vaccinium corymbosum* L.) from the 17 analyzed varieties, grown under the pedoclimatic conditions of Bucharest, are characterized by a variable chemical composition, influenced both by genetic factors and by the environmental conditions specific to the region.

The results confirm that the 17 analyzed varieties largely fall within the parameters specific to cultivated blueberry, demonstrating good agronomic adaptation and appropriate nutritional quality. The identified deviations are limited and can be explained by genetic variability and environmental conditions, without indicating major imbalances. Overall, the mineral and biochemical profile of the studied varieties is representative of the species *Vaccinium corymbosum* L. and confirms their value for both consumption and processing.

The 'Duke', 'Legacy', and 'Blue Ribbon' varieties stood out due to their superior mineral and biochemical profiles and are recommended for producing fruits with high nutritional value under the conditions of the Bucharest area.

REFERENCES

Ashique S., Mukherjee T., Mohanty S., Garg A., Mishra N., Kaushik M., Bhowmick M., Chattaraj B., Mohanto S., Srivastava S.,Taghizadeh-Hesary F. , 2024. Blueberries in focus: Exploring the phytochemical potentials and therapeutic applications. *Journal of Agriculture and Food Research*, 18, (2024) 101300, https://doi.org/10.1016/j.jafr.2024.101300

Aşık B.B., Dorak S., Hazarhun G., 2025. The **d**etermination of plant nutrient content of blueberries grown in different growing wedia**.** *Journal of Biological and Environmental Sciences,* e-ISSN 1308-2019, 19(56), 10-23, https://doi.org/10.5281/zenodo.16262346

Barbu L.D.N., Livadariu O., Boiu-Sicuia O.A., Constantin C.G., Dobrin A., Ion V.A., Venat O.A.C., Nicolae C.I., Badea M., Peticilă A.-G., Lagunovschi Luchian V., Băbeanu N.-E., 2023. Preliminary evaluation on getting sprouts in sorrel on different substrates, *Scientific Papers. Series B, Horticulture. Vol. LXVII*, No. 1, 2023, Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653, 723-730

Bashdar A.S., Rasul J.A., 2023. Determination of essential and trace elements in various vegetables using ICP-MS, *Baghdad Science Journal: Vol. 20*: Iss. 3, Article 17, DOI: https://doi.org/10.21123/bsj.2022.7253

Bujor M., Asănică A., Tudor V., Popescu D., Hera O.V., Teodorescu R.I., 2025. Evaluation of the qualitative characteristics of some new blueberry varieties at USAMV of Bucharest, *Scientific Papers. Series B, Horticulture. Vol. LXIX*, No. 2, 2025 Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653, 101-110

Bujor M., Asănică A., Tudor V., Popescu D., Hera O.V., Teodorescu R.I., 2025. Behavior of some blueberry varieties on different growing systems in the Bucharest area, *Scientific Papers. Series B, Horticulture. Vol. LXIX*, No. 2, 2025 Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653, 91-100

Cabrera C., Carlier E., Zapata L.M.,2021. Mineral composition of blueberries (*Vaccinium corymbosum*) cultivated in the northeast region of Argentina. *Revista Iberoamericana de Tecnología Postcosecha*, ISSN: 1665-020, 71-85

Constantin C.G., Zugravu M.M., Georgescu M., Constantin M.F., Mot, A., Paraschiv, M., Dobrin A., 2023. The Impact of the Growing Substrate on Morphological and Biochemical Features of *Salicornia europaea* L. *Appl. Sci.* 2023, 13, 10835, https://doi.org/10.3390/app131910835

Dróżdż P., Šėžienė V., Pyrzynska K., 2017. Mineral composition of Wild and Cultivated Blueberries, *Biol Trace Elem Res*, DOI 10.1007/s12011-017-1033-z

Kalt W., Cassidy A., Howard L.R., Krikorian R., Stull A.J., Tremblay F., Zamora-Ros R., 2019. Recent Research on the Health Benefits of Blueberries and Their Anthocyanins, Adv Nutr. 2019 Jul 22; 11(2): 224–236. doi: 10.1093/advances/nmz065

Krishna P., Pandey G., Thomas R., Parks S., 2023. Improving Blueberry Fruit Nutritional Quality through Physiological and Genetic Interventions: A Review of Current Research and Future Directions, *Antioxidants* (Basel), 2023 Mar 26; 12(4): 810. doi: 10.3390/antiox12040810

Lachowicz-Wiśniewska S., Pratap-Singh A., Ochiman I., Kapusta I., Kotowska A., Pluta S., 2024. Biodiversity in nutrients and biological activities of highbush blueberry **(***Vaccinium corymbosum* L.**)**. Scientific Reports | (2024) 14:22063, https://doi.org/10.1038/s41598-024-71114-x

Li M.-J., Deng Y.-Y., Pan L.-H., Luo S.-Z., Zheng Z., 2023. Comparisons in phytochemical components and in vitro digestion properties of corresponding peels, flesh and seeds separated from two blueberry cultivars, *Food Sci Biotechnol*. 2023 May 31; 33(1): 73–83. doi: 10.1007/s10068-023-01326-w

Liu X., Zhan G J., Di Y., Wan H., Wang K., Nie J., 2025. Comprehensive Evaluation of Quality and Antioxidant Capacity of Highbush Blueberries (*Vaccinium corymbosum*), *Foods* 2025, *14*(18), 3251, https://doi.org/10.3390/foods14183251

Moț A., Ion V.A., Madjar R.M., Bădulescu L., 2022. Dynamic pregl-dumas technique applied in nitrogen determination from inputs used in organic agriculture. *Scientific Papers. Series A. Agronomy LXV*(2), p. 105-110.

Negrusier C., Colisar A., Rózsa S., Chiș M.S., Sîngeorzan S.-M., Borsai O., Negrean O.-R., 2024. Bilberries vs. Blueberries: A comprehensive review**.** *Horticulturae* 2024, *10*(12), 1343; https://doi.org/10.3390/horticulturae10121343

Rashwan A.K., Osmand A.I., Karimb N., Moa J., Chen W., 2024. Unveiling the Mechanisms of the Development of Blueberries-Based Functional Foods: An Updated and Comprehensive Review, *Food Reviews International*, *vol. 40*, no. 7, 1913–1940, https://doi.org/10.1080/87559129.2023.2245025

Uribe E., Vega-Galvez A., Pasten A., Ah-Hen K.S., Mejias N., Sepulveda L., Poblete J., Gomez-Perez L.S., 2024. Drying: A Practical Technology for Blueberries (*Vaccinium corymbosum* L.) - Processes and their Effects on Selected Health-Promoting Properties, *Antioxidants* (Basel). 2024 Dec 18; 13(12): 1554. doi: 10.3390/antiox13121554

COMMISSION REGULATION (EU) 2023/915 of 25 April 2023 on maximum levels for certain contaminants in food and repealing Regulation (EC) No 1881/2006

SR EN ISO 16634-1 : 2009. Produse alimentare. Determinarea conținutului de azot total prin combustie conform principiului Dumas si calculul conținutului de proteine brute. Partea 1 : Semințe oleaginoase si hrana pentru animale.