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Research on the biochemical quality of fruits on some highbush blueberry cultivars

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Abstract

The highbush blueberry *(Vaccinium corymbosum L.)* is found in the flora of the North-Eastern United States and South-Estern Canada. Blueberries are an important source of antioxidants. These compounds concentration vary according to the cultivars. This study objective was to determine biochemical composition of fruits at optimal harvest maturity on nine varieties. The biochimical indicators studied were: total dry mater content, soluble dry matter, total titrable acidity, sugar content, vitamin C, anthocyanins and polyphenols. Vitamin C was analysed iodometrically, total sugars by Fehling-Soxhlet method, total acidity was measured by titrable method and the soluble dry matter content was determined using a refractometer. Total polyphenols and anthocyanins content of the fruits were analyzed with colorimetric methods. The experimental plot was established in the year 2020 inside a farm from the Arges Meadow. The results of chemical composition analyses showed that the fruits of' Compact' has a the highes total soluble solid content (16.6%).

The highest vitamin C level (15.31 mg/100 g FW) was determined in the fruits of' Blueray'. 'Elliot' fruits presented higher values of titratable acids content (1.18%), total poliphenol and anthocyanins contents (6383.76 mg GAE/kg FW, respectively 3120.54 mg/kg FW). 'Elliot' variety is distinguished by the highest content of antioxidant compounds.

Keywords*:* blueberry, fruit_quality, dry_mater, sugar_content, anthocyanins, polyphenols

1.Introduction

Originally from North America, growing in the hilly and forested regions of northern Europe, blueberries have been noticed and used by the local population since the 16th Century [4, 26]. The major growing areas of highbush blueberries are in the USA followed by California, Florida, Georgia, Michigan, New Jersey, North Carolina, Oregon, Washington, and in some provinces in Canada; gradually they are being propagated all around the world - South America, Australia and New Zealand [35], and more recently have become a popular commercial crop in Europe [10]. The highbush blueberry (*Vaccinium corymbosum*) was brought to Romania in 1968 by Stefan Nicolae (Botez et al., 1984) [2]. The interest for these fruits has increased in Romania in recent years, so that in 2018 a blueberry production of 684 tons was registered in our country [32-34].

Blueberry fruits are excellent table fruits with very high value for maintaining health, treatment and prevention of many diseases, due to the rich content of flavonoids, phenolic acids [20, 29], anthocyanins, polyphenols [28], tannins and stilbenes. Blueberries includes also nutritional compounds such as sugars, vitamins and minerals [32-34].

Consumption of blueberry products has potential health benefits in preventing development of obesity, chronic inflammation, type 2 diabetes, [24]. Anthocyanins contributes to the health-beneficial effects of blueberry against several chronic diseases including cardiovascular disorders, neurodegenerative diseases, cancer [21, 27]. It also have been reportedthat blueberries have an antioxidant, anti-inflammation, antimicrobial, reno-protective, ophtalmo-protective, hepato-protective, gastro-protective, anti-osteoporotic and anti-aging role [14].

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The objective of this study was to biochemically determine the anthocyanins, polyphenols total and other compounds with beneficial properties for health, on some blueberry varieties grown in Southern Romania.

2. Material and Methods

The blueberry fruits were analyzed are five Romanian varieties (‘Compact’, ‘Delicia’, ‘Safir’, ‘Simultan’, ‘Vital’) and other four varieties frequently cultivated on the Romanian territory (‘Blueray’, ‘Duke’, ‘Elliot’, ‘Hanna’h Choise’). The experience was place at a farm in the Arges Meadow on a three yearold blueberry culture. The experimental field was placed, on the flat terrain, clay-brown soil with a loamy to loamy-clayey texture in the first 60-70 cm, and in depth the texture becomes sandy. Along the plants rows the soil was enhanced by adding 30 t/ha acid peat moss. The ground water was about 1.5 m. The fruits of nine highbush blueberry cultivars were obtained from commercial plantation in 2020. The samples were harvested at the optimal stage of maturity.

Biochemical analyzes and laboratory determinations consisted in determining the total content of dry mater, total content of soluble dry matter, titratable acidity, vitamin C, total sugar, total polyphenols and anthocyanin pigments. All biochemical determinations were performed in five repetitions.

Total dry mater content was determined by a gravimetric method (drying 10 g of fruit tissue at 105 °C to constant weight) according to Krełowska - Kułas [1993] [12], Vitamin C content was estimated with iodometric method [23] and expressed in mg / 100g FW. The soluble dry matter content (% Brix) was determined using a refractometer. Total sugar content was estimated by the Fehling-Soxhlet method, 1968 [33]. Titratable acidity (%): total acidity was determined by titrable method [7].The principle of the method is to neutralize a volume of aqueous fruit extract with a solution of NaOH, 0.1N in the presence of phenolphthalein as indicator.The determination of total polyphenols was performed spectrophotocolorimetrically, with the Folin-Ciocâlteu reagent [25] and were expressed as mg GAE /kg FW. For the extraction of polyphenols was used as solvent methanol (70%). The dosage of total anthocyanin pigments in fruits was performed by the Fuleki method (1968) [8].

The method consists in the extraction of anthocyanins with appropriate extractive solutions and the measurement of the absorbance of the extract, spectrophotocolorimetricaly at the wave length λ = 535 nm. The determined total anthocyanins were expressed as cyanidin-3-glucoside mg / kg fresh weight (FW).

Statistical analysis: Data were analyzed employing the variance (ANOVA), using SPSS software. The pair wise comparisons between different parameters were done using Duncan’s test ($P<0.05$).

3. Results and discussions

*Total dry matter content (%). T*he greatest dry matter percentage was found in fruits of the cultivars ‘Elliot’, ‘Delicia’ and ‘Vital’ (16,06%; 15,83% respectively 15,89%) and lowest values (13,26%) in the ‘Blueray’ variety (Fig. 1). Ostrowska and Ściążko (1996) [18], reported a total dry matter content in blueberry of 12,8-15,09%.

Total dry matter content is influenced by variety, fruit size [19], cultivation technologies and climatic conditions.

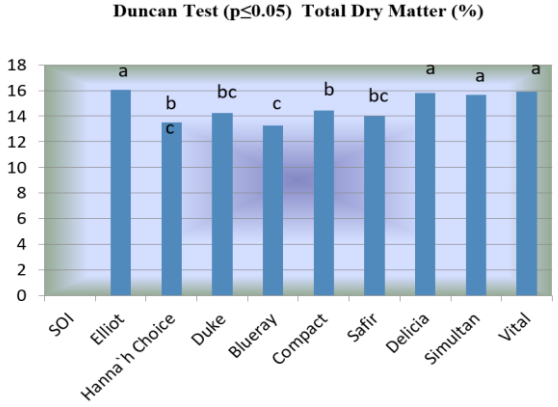

Figure 1. Total dry matter content (%) of the fruits on the blueberry varieties

Total soluble solid (°Brix).Fruit soluble solid content was determined on samples of 20 fruit, randomly collected when fruits had reached maturity. Assessment the total soluble solid content is a commonly used and quick measure for establishment the sweetness of blueberry fruit [9].

This measure of sweetness is often associated with titratable acidity for calculation of the total soluble solid/ titratable acidity [1]. On the studied blueberry varieties the content of total soluble solid varied between 13.84 °Brix (‘Compact’) and 11.00 or 11.3 °Brix (‘Blueray’ and ‘Simultan’), (Fig. 2).

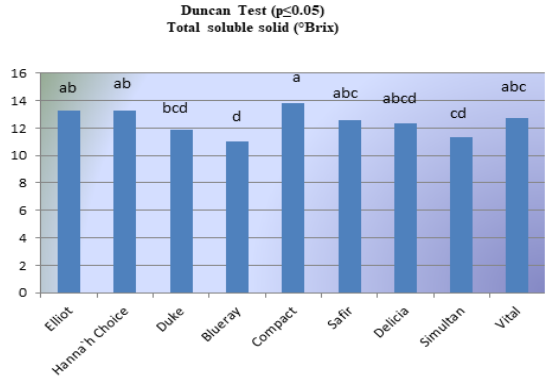

Figure 2. Total Soluble solid (°Brix)

Titratable acidity (expressed as malic acid%). Sugar/acid ratio (soluble solids content/titratable acidity) is an important indicator of fruit quality from an organoleptic point of view in correlation with the flavor intensity [22]. Titratable acidity and total sugar were determined from aqueous blueberry extracts two days after harvest. Total acidity recorded the lowest values (0.41%) in the 'Blueray' variety (Fig. 3) and maximum values for Elliot variety' (1.18%). Average values were obtained on 'Simultan', 'Vital' and 'Duke'. Similar data were reported by Burzo (2015) [3]. According to Andrzejewski [1975] cited by Skupien, (2006) [26] total acids content in blueberries is 0.51–1.77 g · 100 g-1 of fresh weight.

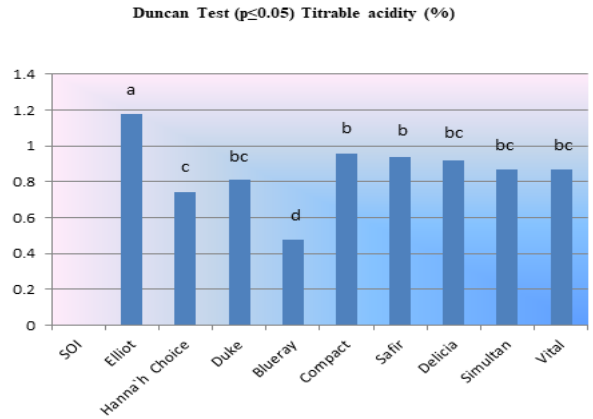

Figure 3.Total titratable acidity (%) of the fruits on the blueberry varieties

The sugar content is an important biochemical indicator used to determine the quality of sweet fruits [17]. The sugar content of the fruits (Fig. 4) varied between the minimum values for the 'Safir' (8.07%) and 'Delicia' varieties (7.97%) and the maximum values for the 'Elliot' variety (10.5%). Several factors (variety, maintenance technology, soil conditions, fruit position in the crown) can influence the value of fruit sugar content [6].

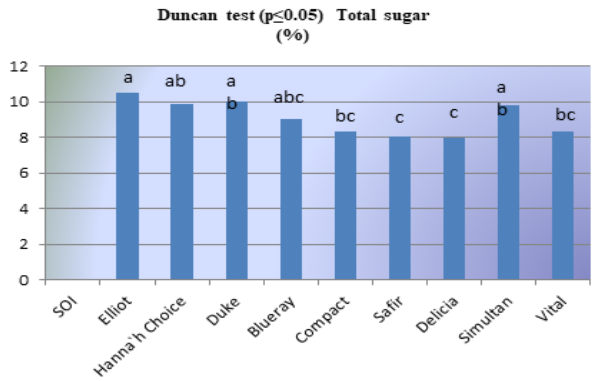

Figure 4.Total sugar content (%) of the fruits on the blueberry varieties

Ascorbic acid content (vitamin C) Vitamin C is an important component in blueberries, an essential antioxidant that helps in neutralising free radicals. Research has shown that blueberries have a vitamin C content ranging from 3 mg to 18 mg per 100 grams [15, 30]. The lowest value of ascorbic acid content was recorded in the 'Safir' and'Vital' varieties (11,84 mg/100 g FW respectively 11,59 mg/100g FW) and the highest were obtained in the 'Blueray', 'Simultan', 'Compact' and 'Duke' varieties (15,31 mg/100 g FW; 14,34 mg/100 g FW; 14,00 mg/100g FW and 14,11 mg/100 g FW, respectively), (Fig. 5).

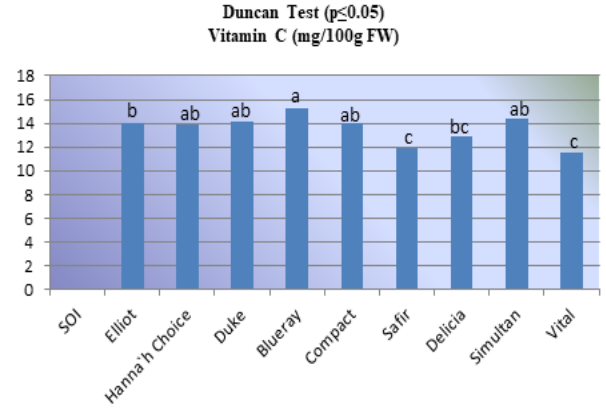

Figure 5.Vitamin C content ((mg/100g FW) of the fruits on the blueberry varieties

Polyphenol content. The total phenolic content is thought to be influenced more by genotype than by environmental conditions [5]. The results obtained regarding the polyphenol content varied between 6383,74 mg GAE/kg ('Elliot') and 2726,82 mg GAE/kg ('Safir'), average values registering the varieties 'Hanna'hChoise', 'Duke', 'Compact' and 'Simultan' (Fig. 6).

Okan et al., 2018 [17] reported a total blueberry polyphenol content of 215.12 mg GAE / 100 g FW. According to Kim et al (2013) [11], total phenolic content ranged from 1709.0 to 5238.0 mg gallic acid per Kg FW in the highbush blueberry fruits.

The differences in total phenolic contents between some cultivars were statistically significant.

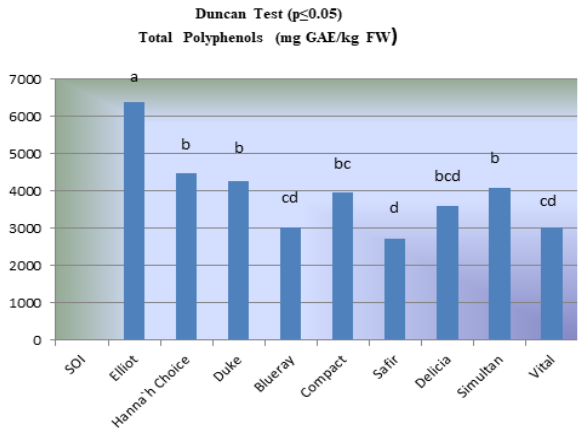

Figure 6. Total polyphenol content (mg GAE/kg). of the fruits on the blueberry varieties

Content of anthocyanin. In the fruits of the 9 varieties of highbush blueberries studied, the content of anthocyanin pigments varied in very wide limits, from 3120.54 mg / kg FW ('Elliot') to 760.75 mg / kg FW ('Delicia') (Fig. 7).

Similar results obtained and Okan et al., 2018 which reported a total anthocyanins content of 430,3 - 2950,6 mg c3-GE / KG FW. For highbush blueberries, Mazza and Miniati (1993) [13, 16] have reported a range of 250 to 4950 mg/kg anthocyanins, total anthocyanins, and total phenolic content 131.2 mg GAE/kgFW [30].

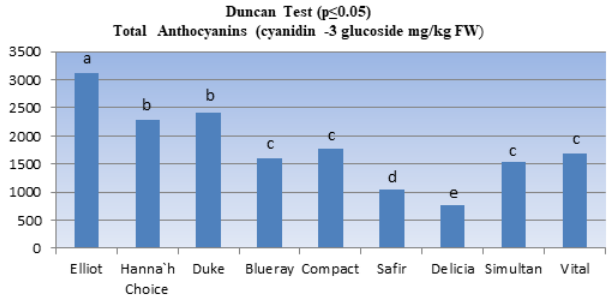

Figure 7. Total anthocyanins content (mg/kg FW) of the fruits on the blueberry varieties

Table 1. Pearson correlations coeficients for the biochemical quality indicators for the studied blueberry varieties

	Moisture content	*Total dry matter content*	*Total soluble solid*	Juice pH	*Titratable acidity*	*Total sugar content*	*Ascorbic acid content*	*Polyphenol contents*	Anthocyanins content
Moisture content	x	-,985**	-0,085	,406**	-,348**	-0,119	0,161	-0,153	-0,071
Total dry matter content		x	0,108	-,388**	,337**	0,089	-0,157	0,145	0,069
Total soluble solid			x	-0,13	0,165	0,035	0,027	0,141	0,184
Juice pH				x	-,560**	0,019	,371**	-0,22	-0,06
Titratable acidity					x	-0,014	-,275*	,358**	,286*
Total sugar content						x	,286*	,258*	,374**
Ascorbic acid content							x	,370**	0,222
Polyphenol content								x	,617**

Assessment of the table 1 and figure 8, highlights the correlation values and strenght obtained between some biochemical componds from blueberry fruits. In this sense pozitive and distinct significant correlation Pearson coefficients, statisticaly insured, were found between fruits moisture content and total dry matter content (-0,985**), juice pH (0,406**) and titrable acidity (-0,348**).

The same sort of correlations were found between total dry matter content and juice pH (-0,388**) and titrable acidity (0,337**).

The juice pH was correlated with titrable acidity (0,560**) and ascorbic acid content (vitamin C) 0,371**. Also, titrable acidity was distinct significant correlated with the polyphenols content (0,358**) and anthocyans content (0,286*). At the same time, total sugar content was correlated with ascorbic acid (0,286*) polyphenol (0,258*) and anthocians contents (0,374**).

Ascorbic acid content was distinct significant positive correlated with polyphenol (0,370*).

Also, polyphenol content was correlated with fruits anthocyans content (0,617**).

4.Conclusion

- The assessment of blueberry fruits quality reveal some strong correlations between some active biochemical compounds.
- The blueberry fruits harvest at the right time is a prerequisite of their quality and content in active ingredients.
- Among the 9 studied varieties 'Elliot' was distinguished by the highest content of antioxidant compounds.

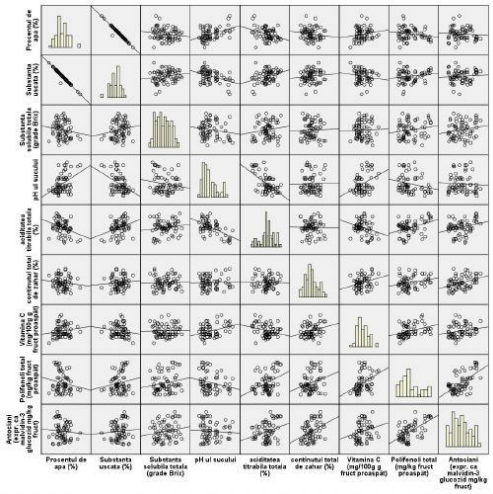

Figure 8. Matrix of correlations between biochemical indicators studied in blueberry fruits

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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