GENOTYPIC DISTINCTIONS OF VARIABILITY OF BIOCHEMICAL COMPOSITION OF FRUITS OF *VACCINIACEAE* SPECIES UNDER CONDITIONS OF BELARUS

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Result of research of quantitative characteristics of biochemical composition of fruits of 30 taxons of 3 *Vacciniaceae* species (such as *V. corymbosum L.* (highbush blueberry), *V. vitis-idaea* L. (lingonberry) and *Oxycoccus macrocarpus* (Ait.) Pers. (cranberry)) inter-specific distinctions of a degree of stability of its separate components to complex influence of meteorological factors are revealed by 32 parameters (traits) describing the contents in fruits of some organic acids, carbohydrates, phenolic compounds, terpenoids and major mineral elements are presented. The cultivars possessing by the greatest and accordingly by the least levels of dependence on abiotic factors are identified.

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The major aspect of researches connected with in-depth study of species of berry plants is the estimation of complex biochemical composition of fruits in a long-term cycle of the supervision, which gives to us the information not only about its genotypic features, but also about the degree of dependence on hydrothermal regime during the period of fruits maturing and of parameters about accumulation of wide spectrum of the useful substances determining organoleptic properties of berry production. The response of the introduced species to influence of complex meteorological factors particularly the extremely unstable character of weather conditions during vegetation of plants and maturing of their fruits, peculiar to the Belarus region, can noticeably influence on the rates of accumulation of those or other compounds. This information may lead to correcting action to enhance their nutritious and vitamin values. In the last few years, the Central Botanical Garden of the NAS of Belarus has introduced new taxons of 3 *Vacciniaceae* species (*V. corymbosum L.* (highbush blueberry), *V. vitis-idaea* L. (lingonberry) and *Oxycoccus macrocarpus* (Ait.) Pers. (cranberry). It has created additional opportunities to increase the varieties offered for breeding to select the most perspective variety. The selection may be made on nutritious and vitamin values of the berry production as defined by its biochemical composition and also on the degree of constancy of biochemical composition in the face of influence of complex meteorological factors.

It is, however, expected that there will long-term stable genotypic distinctions. It will enable to designate cultivars which exhibit least dependence on abiotic factors. The object of this work is to establish quantitatively the degree of dependence of biochemical composition of fruits of investigated *Vacciniaceae* species on the hydrothermal regime of a season

Experimentals

Studies have been done during the years 2006-2008, on the plant material received at Gantsevichi research station of Central Botanical Garden of the NAS of Belarus (the Brest region). Intra- and inter-seasonal weather conditions during July-September, the active period of maturing of fruits of *Vacciniaceae* species, varied considerably. It has not created conditions stability of biochemical compositions of their fruits. The lowest temperature during the given period was recorded in 2008, and the highest one in 2006. All of three seasons were characterized by plentiful atmospheric precipitates with extremely non-uniform distribution in time.

Table 1. Values of hydrothermal factor (Htf) during formation and maturing of fruits of plants of *Vacciniaceae* species (Percentage deviation from the mark is given in the second line).

Year	May	June	July	Aug.	Sep.	Mean
2006	<u>1.8</u> 120.0	<u>1.1</u> 73.3	<u>1.6</u> 100.0	<u>3.0</u> 200.0	<u>0.8</u> 44.4	<u>1.7</u> 106.2
2007	<u>1.4</u> 93.3	<u>1.0</u> 66.7	<u>5.4</u> 337.5	<u>0.4</u> 26.7	<u>0.8</u> 44.4	<u>1.8</u> 112.5
2008	<u>2.3</u> 153.3	<u>0.7</u> 46.7	<u>2.4</u> 150.0	<u>1.3</u> 86.7	<u>3.8</u> 211.1	<u>2.1</u> 131.2
Mean of 3 years	1.5	1.5	1.6	1.5	1.8	1.6

Most objective integrated representation about the character of a weather situation within the years of supervision, on our opinion, can be made on monthly values of the hydrothermal factor determined by a ratio of amount of atmospheric precipitation dropped out and the sum of active temperatures above 10 °C.[1] Our estimates are given in table

1, and according to Seljaninov's gradation of a degree of humidity of any area, in 2006 May and July were characterized by sufficient humidity, June and September had drought and only August had excess humidity. In 2007, May experienced sufficient humidity, June, August and September had mainly by dry weather and only July had large excess of humidity. In 2008, May, July and particularly September were characterized by the excess humidity combined with the low background temperature. August differed by having sufficient humidity whereas June had droughty.

The samples for the investigation comprised of mature fruits of 16 cultivars of *Vaccinium corymbosum L.* (early-maturing: *Bluetta*, *Northblue*, *Weymouth*, *Duke*, *Reka*, *Earliblue*, *Patriot*, *Spartan*, *Puru*, *Nui*, mid-ripening: *Bluecrop*, *Northland*, *Toro*, *Jersey*; late-ripening: *Elizabeth* and *Coville*), of 10 cultivars of *V. vitis-idaea* L. (*Koralle*, *Red Pearl*, *Rubin*, *Erntedank*, *Erntesegen*, *Erntekrone*, *Ammerland*, *Masovia*, *Sanna*, *Sussi*) and of 4 cultivars of *Oxycoccus macrocarpus* (Ait.) Pers. (*Stevens*, *Ben Lear*, *McFarlin*, *Piligrim*).

Biochemical composition of fruits of above-mentioned taxons has been analysed for 32 parameters. In the average fresh samples of a plant vegetative material the contents of dry matter was determined in accordance to GOST.[2] Vitamin C was determined by the standard indophenolic method and organic acid by the volumetric method.[3] In the samples of fruits, after being dried at 65 °C, nitrogen, phosphorus, potassium were determined by the method of Fomenko and Nesterov,[4] calcium, magnesium by the complexometric method,[3] glucose, fructose, sucrose by Zavadskaja's process,[5] pectin substances (water-soluble pectin and protopectin) by carbazolic method.[3] Total anthocyanins was determined by construction of a calibration curve with crystal cyanidin.[6] Cyanidin was obtained from fruits of black chokeberry and was purified,[7] a formula given by Tanchev[8] was used in calculations. Anthocyanins was determined by the method of Shnajdman and Afanaseva,[9] total flavonoids by the method of Sarapuu and Mijdla,[10] catechines by a photometric method with vanillin reagent,[11] chlorogenic acids by the method of paper chromatography,[12] tannins by titirimetric method of Levental,[13] lignins by the modified method of Klason,[3] benzoic acid by Kalebin and Kolesnik's method,[14] fixed oils by Sapunov and Fedunjak's method[15] triterpene acids (in recalculation on ursolic acid) by Simonjan's method.[16]

All analytical definitions are carried out in thrice-repeated biological repeatability by Laboratory of Plant Chemistry of Central Botanical Garden of the NAS of Belarus. The data are statistically processed with use of program MS Excel.

For the estimation of genotypic variability of parameters of accumulation of the specified compounds in a spectrum of investigated taxons in a long-term cycle of supervision we were guided by variation coefficient values (V) of the examined traits. The comparative analysis of the materials has enabled us to establish which biochemical characteristics of fruits of the introduced species are less susceptible to the external influences and which are more susceptible. It is also possible to define the integrated degree of susceptible to the external influences of all the investigated taxons. It is well established that a degree of variation of a specific trait is proportional to its dependence on investigated factors, here on meteorological factor. By estimations of Sennov and Kovjazin,[17] the variability of for biological properties is considered small if it is within the limits of 11-30 % and considered big if exceeds 31%. By consideration of the information presented in our paper, we should consider active reaction of introduced species on the breeding process, allowing in the certain measure to resist to it and to regulate the biochemical composition of generative organs within the limits of genetically determined ranges of a variation of each trait. It has permitted the basis to narrow the border of designated above small variability of row for examined parameters up to 10 %. Its average range was characterized by a level of variability within the limits of 11-20 %, and maximal over 20 %. The accepted gradation of levels of variability of analyzed traits coincides with the recommended for biological objects gradation by Zajtsev.[18]

Results and discussion

We have observed a very wide range of variation in long-term cycle of observations averaged for the varietals series introduced species 32 quantitative indicators of the biochemical composition of fruits in table 2, indicating a significant impact on the abiotic factors. The greatest number of parameters with the maximal values for all of investigated species is observed in the hottest season of 2006. The hot season stimulated accumulation of the majority of useful substances such as organic acids, vitamin C, soluble sugars, bioflavonoid, pectin, terpenoids and phosphorus compounds. The largest number of parameters with the minimal values is foundfor *V. corymbosum L.* cultivars in 2007 and for *V. vitis-idaea* L. and *Oxycoccus macrocarpus* (Ait.) Pers. cultivars in 2008. In all the species, accumulation of benzoic and chlorogenic acids in fruits was the maximum in 2007 indicated by maximal values of a sugar-acid index. Similarly, accumulation of flavonols and most of the macronutrients was the maximum in 2008.

An analysis of data presented in Tables 3 and 4, has revealed a wide ranges of changes in variation coefficients of biochemical composition of fruits of investigated taxa of *Vacciniaceae* species in a long-term cycle of supervision. It testifies to a different level of their dependence on a hydrothermal regime of a season and allowed to designate the traits possessed by the greatest and accordingly by the least degree of this dependence.

Within the years of supervision the majority of parameters of biochemical composition of fruits of *V. corymbosum L.*, irrespective of maturing terms, were inherent of average (V=11-20 %) and high (V>20 %) levels of variability (accordingly for 16-44 % and 44-69 % of parameters). Only for 9-22 % of parameters the levels of variability were low (V<10 %). Biochemical composition of fruits of investigated taxons of *Oxycoccus macrocarpus* (Ait.) Pers. species has been noted by similarity of individual share of analyzed traits within the limits of each level of variability (low level for 12-25 %, average level for 19-38 % and high level for 40-63 % of parameters)

Table 2. Range of changes of averaged quantitative characteristics of biochemical composition of fruits (in dry substance) for *Vacciniaceae* cultivar rows in a long-term cycle of supervision.

Chemical composition	*V. corymbosum L.*	*V. vitis-idaea* L.	*O. macrocarpus* (Ait.) Pers.
Dry matter, %	13.90-14.10	14.90-16.90	10.30-12.50
Organic acid, %	3.80-6.70	14.60-19.30	20.60-36.10
Vitamin C, mg %	426.60-604.80	304.30-670.80	463.60-495.10
Glucose, %	4.49-5.34	5.65-5.95	5.18-6.96
Fructose, %	7.26-18.74	6.85-10.54	1.37-6.86
Sucrose, %	0.56-3.19	0.86-2.09	0.36-0.51
Total sugar, %	12.79-27.25	14.72-18.27	6.91-12.69
Fructose/ Glucose ratio	1.70-3.60	1.20-1.90	0.30-1.30
Monose/Disaccharide ratio	7.90-22.70	6.50-17.40	24.60-28.10
Sugar-acid index	2.50-6.50	0.80-1.30	0.30-0.60
Hydropectin, %	1.98-2.37	2.56-3.03	2.22-2.54
Protopectin, %	2.60-3.45	3.45-3.84	3.56-5.40
Total pectins, %	4.77-5.71	6.01-6.73	6.10-7.65
Protopectin/Hydropectin ratio	1.20-1.80	1.30-1.50	1.40-2.50
Anthocyanins, mg %	2.00-17.10	1.60-3.90	6.70-12.00
Leucoanthocyanins, mg %	12.10-24.10	29.70-32.70	25.10-37.70
Total anthocyanic pigments, mg %	14.10-41.20	32.80-36.60	34.80-49.70
Catechines, mg %	570.10-984.30	710.00-1777.80	1067.10-1823.30
Flavonols, mg %	1626.00-1890.60	1618.90-2227.50	1349.10-3112.90
Flavonols/Catechines ratio	1.90-3.40	1.10-3.70	1.40-3.00
Total bioflavonols, mg %	2501.80-2776.00	2970.30-3719.80	2596.00-4227.00
Chlorogenic acids, mg %	781.40-800.30	484.90-838.10	486.80-700.50
Benzoic acid, %	1.11-1.18	1.14-1.65	1.12-1.49
Tannins, %	1.21-1.83	1.98-2.45	1.76-2.01
Lignins, %	11.30-11.70	10.70-11.90	10.00-13.20
Fixed oils, %	3.17-3.61	5.16-6.09	4.43-5.35
Triterpene acids, %	2.49-3.22	2.58-3.41	2.09-3.44
Nitrogen, %	0.76-1.10	1.19-1.24	0.85-1.03
Phosphorus, %	0.14-0.17	0.14-0.18	0.13-0.16
Potassium, %	0.53-0.76	0.51-0.90	0.58-0.80
Calcium, %	0.31-0.42	0.32-0.39	0.24-0.30
Magnesium, %	0.08-0.11	0.08-0.11	0.08-0.10

For fruits of *V. vitis-idaea* L. the essential increase in a time-row, in comparison with the previous *Vacciniaceae* species, of a relative share of traits with small variability (up to 16-41 %) has been shown. It exclusively possible due to decrease of levels of variability of traits with high variability up to 35-53 % (Table 3 and Table 4), that testifies about the less susceptibility of biochemical composition of fruits of these cultivars to complex influence of abiotic factors.

In our opinion, it is connected with participation in breeding process of the *V. vitis-idaea* L. cultivars of its wild-growing forms selected on the European continent in woodlands of Sweden, Finland, Holland, Germany, Poland and other countries, which are similar by character of soil-climatic conditions to those of Belarus, whereas *V. corymbosum L.* and *Oxycoccus macrocarpus* (Ait.) Pers. are natives from remote North American continent with essentially differing set of climatic and natural factors.[18] It is quite natural, that at adaptation of plants under different conditions leads to more susceptibility to abiotic changes. Thus some of the parameters of biochemical composition of fruits were characterized by relative stability of a level of variability within the limits of cultivar rows of all of three investigated *Vacciniaceae* species.

In the majority of cases the conformity of a level of variability of these parameters of the certain area of the accepted gradation took place only at separate taxons, and frequently the range of changes of a level of variability of traits within the limits of cultivar row covered all of three areas of the shown gradation.

In our view, the most objective representation about a degree of variability of quantity traits of biochemical composition of fruits in varietals rows of investigated *Vacciniaceae* species can give the value of variation coefficient averaged in a 3-years cycle of supervision. The variability of traits, testifying to their stability to atmospheric influences are presented in table 5. In this case it is possible to divide the analyzed traits into 3 groups, according to a level of genotypic variability:

(1) with low variability (*V*=8.2-10.9 % at a blueberry; *V*=6.7-9.0 % at a cowberry; *V*=5.9-10.4 % at a cranberry);

(2) with average variability (*V*=12.2-20.0 % at a blueberry; *V*=11.1-20.0 % at a cowberry; *V*=11.3-18.4 % at a cranberry);

Table 3. Averaged variation coefficients (%) of quantitative characteristics of biochemical composition of fruits for *Vaccinium corymbosum L*. cultivars in a long-term cycle of supervision ((1 – Bluetta, 2 – Northblue, 3 – Weymouth, 4 – Duke, 5 – Reka, 6 – Earliblue, 7 - Spartan, 8 - Puru, 9 - Nui, 10 - Patriot, 11 - Bluecrop, 12 - Northland, 13 - Toro, 14 - Jersey, 15 - Elizabeth, 16 - Coville)

Chemical composition	**Early-maturing**										**Mid-ripening**				**Late-ripening**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Dry matter	8.7	9.7	7.6	7.4	9.2	16.6	8.5	3.6	3.8	14.6	8.1	6.3	10.4	9.9	3.4	3.0
Organic acid	28.9	20.5	16.0	19.3	39.6	61.3	54.5	39.3	9.3	43.2	24.9	13.1	33.8	63.2	55.3	52.1
Vitamin C	36.0	45.5	54.2	46.7	15.1	36.3	5.4	8.0	15.9	26.4	15.5	42.5	17.2	32.1	25.9	6.4
Glucose	19.1	17.9	18.3	17.9	15.3	32.6	17.9	13.5	12.6	10.1	4.7	10.4	11.5	14.6	18.5	16.9
Fructose	45.2	37.4	40.0	34.5	31.7	46.8	32.0	36.4	41.6	54.4	51.9	40.5	50.3	49.5	51.3	54.3
Sucrose	64.9	68.8	69.5	62.8	65.1	66.9	74.6	54.5	64.2	68.7	73.1	69.8	82.0	80.8	64.9	63.6
Total sugar	38.8	35.6	36.6	33.2	30.8	32.4	32.8	33.3	37.8	38.7	40.7	33.1	36.7	40.0	36.5	36.5
Fructose/ Glucose ratio	39.6	23.1	32.1	16.9	18.9	60.1	15.4	25.1	29.3	52.5	48.1	38.7	53.4	48.3	58.9	61.6
Monose/Disaccharide ratio	57.4	61.0	72.7	67.4	56.0	40.3	87.7	43.8	54.5	43.3	53.4	65.8	74.0	83.5	57.8	55.1
Sugar-acid index	51.1	32.8	26.1	31.8	53.2	26.8	70.7	53.9	47.0	60.7	50.0	44.9	51.3	66.7	74.5	67.8
Hydropectin	20.8	5.4	19.0	21.6	8.5	23.8	29.0	6.5	13.9	26.1	6.8	31.8	8.2	32.7	21.8	30.4
Protopectin	35.6	37.0	29.6	18.5	32.8	25.6	20.6	22.7	26.3	14.9	23.5	17.7	15.7	22.3	5.2	24.3
Total pectins	27.8	22.1	14.3	18.8	22.4	14.9	14.5	14.4	19.1	19.9	11.1	23.4	12.0	26.1	13.0	21.6
Protopectin/Hydropectin ratio	28.4	32.9	49.9	11.4	25.5	45.5	47.1	20.0	18.2	14.4	32.2	13.6	6.0	19.5	18.7	31.9
Anthocyanins	91.7	112.6	47.3	62.9	81.7	62.1	88.1	119.0	118.3	73.5	90.9	109.8	124.1	102.3	101.6	72.2
Leucoanthocyanins	26.2	34.8	46.6	41.3	33.1	50.7	15.2	16.2	17.0	37.1	34.6	45.7	68.6	55.0	46.3	27.1
Total anthocyanic pigments	45.9	62.8	45.4	46.7	38.7	39.8	41.4	44.9	55.0	48.8	42.8	65.7	85.7	68.3	67.2	40.2
Catechines	30.3	31.2	36.4	35.6	43.6	14.6	25.9	37.3	21.3	17.7	26.2	46.6	34.1	43.7	39.8	44.8
Flavonols	11.7	18.9	17.0	13.4	7.7	5.8	16.1	15.2	5.8	9.1	14.8	7.3	9.1	3.7	10.5	8.2
Flavonols/Catechines ratio	39.3	42.7	52.2	56.8	52.6	17.9	37.4	50.7	26.6	19.6	22.3	48.0	50.7	58.5	53.4	55.9
Total bioflavonols	7.1	14.4	3.6	7.5	8.8	2.3	7.9	4.3	4.7	8.4	15.2	18.2	9.2	11.7	8.4	19.1
Chlorogenic acids	11.5	28.6	10.9	19.4	21.3	12.8	23.6	12.2	12.4	16.9	12.2	9.6	11.8	27.8	3.0	27.8
Benzoic acid	6.7	5.9	18.8	21.9	5.5	11.2	15.5	13.3	21.7	7.6	15.6	16.3	13.1	7.9	11.4	7.5
Tannins	10.6	20.7	32.6	30.1	12.2	23.3	38.8	31.9	31.9	17.7	33.4	15.0	21.8	37.8	27.6	16.6
Lignins	18.7	27.3	12.4	13.4	16.5	4.1	7.9	24.7	9.4	15.2	7.4	13.2	7.3	2.5	1.6	13.8
Fixed oils	24.9	38.2	14.4	20.7	34.0	38.7	25.0	12.9	20.0	15.0	23.7	20.3	31.9	11.2	21.6	18.0
Triterpene acids	19.5	27.3	24.3	14.9	21.5	14.0	6.2	11.5	8.9	24.4	6.4	16.9	23.4	9.4	20.2	20.6
Nitrogen	26.7	24.3	16.8	8.4	12.3	19.1	31.4	31.9	23.7	13.9	21.1	28.4	19.5	12.0	15.3	17.8
Phosphorus	5.6	9.9	8.7	13.1	8.1	10.0	16.4	9.4	7.4	22.7	13.3	30.2	31.2	30.6	10.4	24.7
Potassium	23.5	22.4	23.5	12.1	10.4	13.8	18.2	15.4	25.8	14.4	7.5	21.8	25.5	20.6	32.5	32.8
Calcium	6.8	5.4	10.2	17.3	15.9	9.4	11.8	19.7	15.0	16.4	26.5	18.9	18.7	11.8	19.5	21.5
Magnesium	17.6	12.4	22.2	11.2	15.8	26.0	15.8	23.9	11.1	19.2	16.4	13.3	12.5	19.2	18.3	16.4
V mean	**28.9**	**30.9**	**29.0**	**26.7**	**27.0**	**28.3**	**29.8**	**27.2**	**25.9**	**27.7**	**27.3**	**31.2**	**33.1**	**35.1**	**31.7**	**31.6**

Table 4. Averaged variation coefficients (%) of quantitative characteristics of biochemical composition of fruits for *Vaccinium vitis-idaea* L. and *Oxycoccus macrocarpus* (Ait.) Pers. cultivars in a long-term cycle of supervision (1 - Koralle, 2 - Red Pearl, 3 - Rubin, 4 - Erntedank, 5 - Erntesegen, 6 - Erntekrone, 7 - Ammerland, 8 - Masovia, 9 - Sanna, 10 - Sussi, 11 - Stevens 12 - Ben Lear, 13 - Mc Farlin, 14 - Piligrim)

Chemical composition	***Vaccinium vitis-idaea* L. cv.**									***Oxycoccus macrocarpus* (Ait.) Pers. cv.**				
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Dry matter	14.6	5.3	3.7	7.8	8.4	11.3	5.1	11.9	10.2	1.7	13.0	2.0	6.2	15.6
Organic acid	19.1	22.0	15.2	20.2	16.6	39.8	9.0	7.5	6.8	12.5	35.1	18.7	17.2	25.0
Vitamin C	42.7	28.9	33.9	57.3	45.7	62.0	4.7	29.6	31.2	21.7	8.8	5.3	1.6	7.9
Glucose	11.4	6.1	6.0	7.0	6.6	8.7	4.6	5.1	9.7	6.4	17.1	16.4	19.3	16.4
Fructose	20.9	28.0	21.1	27.2	23.4	24.6	17.9	32.6	2.4	1.7	60.4	72.0	67.6	53.8
Sucrose	45.7	23.4	36.6	28.4	48.0	48.4	50.2	47.2	78.7	64.1	19.7	6.1	26.2	59.2
Total sugar	11.6	14.7	13.8	17.6	13.0	13.2	13.4	20.2	5.2	4.8	27.5	29.7	33.0	32.4
Fructose/ Glucose ratio	29.0	28.8	16.2	23.1	30.4	31.2	18.0	30.7	12.0	8.1	75.4	103.7	87.0	61.1
Monose/Disaccharide ratio	41.8	30.5	48.7	38.1	60.6	69.3	64.3	63.4	80.5	65.0	42.8	25.5	24.4	51.4
Sugar-acid index	19.3	40.6	30.7	35.3	22.1	41.7	4.9	27.7	12.0	7.7	43.3	25.0	44.6	58.1
Hydropectin	4.8	6.4	10.6	7.5	12.1	7.5	9.4	22.7	6.7	2.4	28.2	11.0	1.4	6.1
Protopectin	4.9	12.5	21.5	11.2	17.8	10.5	10.3	18.6	1.5	23.0	29.5	28.1	23.2	7.6
Total pectins	1.4	8.0	16.3	9.6	8.5	2.7	9.3	13.6	2.5	15.3	15.7	17.7	15.0	6.6
Protopectin/Hydropectin ratio	39.5	13.3	16.5	4.3	26.2	18.2	8.3	31.5	6.7	21.4	51.7	33.1	21.5	7.4
Anthocyanins	88.4	40.9	27.3	86.9	117.5	139.1	46.9	86.6	4.3	141.4	52.5	23.2	49.8	22.3
Leucoanthocyanins	13.4	38.7	33.8	3.0	63.6	39.6	11.7	49.5	51.3	13.0	40.2	11.4	26.6	17.3
Total anthocyanic pigments	18.5	38.3	33.0	7.3	65.9	46.3	9.8	50.1	100.4	86.9	40.8	5.7	30.3	17.4
Catechines	32.5	9.1	35.7	67.1	48.1	97.0	50.3	55.7	97.1	54.8	46.1	24.8	36.7	32.8
Flavonols	25.1	16.6	15.8	22.5	11.0	13.0	16.3	7.5	23.4	28.6	48.5	57.7	56.6	37.0
Flavonols/Catechines ratio	51.2	27.3	55.5	96.3	45.8	83.1	81.1	51.5	108.5	76.1	79.6	53.9	66.3	63.5
Total bioflavonols	13.1	5.2	6.7	21.0	18.7	38.2	12.5	24.4	36.7	1.1	30.5	32.0	25.9	11.1
Chlorogenic acids	9.6	31.4	40.6	28.3	27.8	10.5	36.4	30.6	33.1	19.1	22.1	10.5	24.3	24.1
Benzoic acid	5.6	15.1	22.0	20.2	6.9	26.1	16.9	28.0	27.1	46.8	20.0	21.6	9.8	15.0
Tannins	9.0	42.9	9.9	16.2	8.7	46.9	14.0	40.1	21.9	8.7	20.0	8.4	10.6	2.7
Lignins	12.9	2.4	2.1	18.5	4.6	5.5	4.8	4.9	26.7	5.2	31.3	19.5	10.0	1.7
Fixed oils	11.0	6.8	4.4	7.7	16.5	16.9	14.4	23.1	3.9	11.2	7.8	8.3	9.8	14.5
Triterpene acids	9.8	11.9	15.8	12.6	13.0	13.6	23.7	15.8	14.4	20.7	32.5	12.6	32.8	26.3
Nitrogen	4.8	7.0	6.6	3.6	7.6	9.3	2.0	8.6	12.6	4.8	6.7	14.8	11.4	12.2
Phosphorus	7.4	19.7	7.4	16.5	17.6	3.7	19.5	22.5	4.9	5.7	0	6.3	17.6	16.4
Potassium	24.5	30.5	30.1	30.1	32.8	39.5	40.2	32.5	22.0	25.5	21.4	18.6	17.9	15.5
Calcium	14.8	14.7	12.9	4.4	12.7	11.5	15.2	13.6	3.7	7.6	12.3	13.4	9.0	18.4
Magnesium	18.3	16.4	16.4	16.4	10.0	16.4	11.1	19.2	14.1	22.3	18.3	18.3	22.2	13.3
V mean	**21.1**	**20.1**	**20.8**	**24.2**	**27.1**	**33.6**	**20.5**	**29.0**	**27.3**	**26.1**	**31.2**	**23.6**	**26.7**	**24.1**

(3) with high variability (*V* = 20.9-75.9 % at a blueberry; *V*=20.1-48.6 % at a cowberry; *V*=20.4-40.3 % at a cranberry).

The analysis of data resulted in Table 5 revealed that in some cases similarity of parameters of variability of the analyzed traits describing a degree of inter-seasonal distinctions in a long-term cycle of supervision at all of investigated cultivars of *Vacciniaceae* species. So the least expressive (within the limits of low variability) they have appeared only in a single instance, for the dry substances contents in fruits. The generality of an average level of the shown distinctions notes parameters of accumulation in fruits of calcium and magnesium. For a much greater set of parameters like contents of sucrose, of anthocyanins, of catechines and also of ratio of fractions of soluble sugars, of bioflavonols, and of values of a sugar-acid index at all of investigated *Vacciniaceae* species have been established a high level of variability in a time row.

At the same time the results of long-term supervision revealed that the taxons of *Vacciniaceae* species possess the greatest susceptibility and consequently the least stability of biochemical composition of fruits to external influences A degree of variability of biochemical composition of fruits as a whole in a long-term cycle of supervision for all the cultivars of *Vacciniaceae* species has been determined. The data, presented in tables 3 and 4 indicated that variation coefficients in a spectrum of cultivars of investigated *Vacciniaceae* species are 25.9 % for blueberry, for cowberry it is 20.1-33.6 % and 23.6-31.2 % for cranberry.

It has been determined, on the basis of the values of the variation coefficients, that all the taxons can be arranged in the following order of degree of stability of biochemical composition of fruits against the atmospheric influences in a long-term cycle of supervision:

For cultivars of *Vaccinium corymbosum L.*:

Nui>Duke>Reka=Puru=Bluecrop>Patriot>Earliblue > Bluetta = Weymouth > Spartan > Northblue = Northland > Coville = Elizabeth > Toro > Jersey

For cultivars of *Vaccinium vitis-idaea* L.:

RedPearl>Ammerland>Rubin>Koralle>Erntedank>Sussi> Erntesegen=Sanna>Masovia>Erntekrone

For cultivars of *Oxycoccus macrocarpus* (Ait.) Pers.:

Ben Lear>Piligrim>McFarlin>Stevens

Table 5. Averaged variation coefficients (%) of quantitative characteristics of biochemical composition of fruits for *Vacciniaceae* cultivar rows in a long-term cycle of supervision

Chemical composition	***V. corymbosum***	***L.V. vitisidaea***	***Oxycoccus macrocarpus (Ait.) Pers.***
Dry matter	8.2	8.0	9.2
Organic acid	35.9	16.8	24.0
Vitamin C	26.8	35.8	5.9
Glucose	15.7	7.2	17.3
Fructose	43.6	20.0	63.4
Sucrose	68.4	47.1	27.8
Total sugar	35.8	12.8	30.6
Fructose/ Glucose ratio	38.9	22.8	81.8
Monose/Disaccharide ratio	60.9	56.2	36.0
Sugar-acid index	50.6	24.2	42.8
Hydropectin	19.1	9.0	11.7
Protopectin	23.3	13.2	22.1
Total pectins	18.5	8.7	13.8
Protopectin/Hydropectin ratio	26.0	18.6	28.4
Anthocyanins	91.1	77.9	37.0
Leucoanthocyanins	37.2	31.8	23.9
Total anthocyanic pigments	52.5	45.6	23.6
Catechines	33.1	54.7	35.1
Flavonols	10.9	18.0	50.0
Flavonols/Catechines ratio	42.8	67.6	65.8
Total bioflavonols	9.4	17.8	24.9
Chlorogenic acids	16.4	29.7	20.2
Benzoic acid	12.5	21.5	16.6
Tannins	25.1	21.8	10.4
Lignins	12.2	8.8	15.6
Fixed oils	23.2	11.6	10.1
Triterpene acids	16.8	15.1	26.0
Nitrogen	20.2	6.7	11.3
Phosphorus	15.7	12.5	10.1
Potassium	20.0	30.8	18.4
Calcium	15.3	11.1	13.3
Magnesium	17.0	16.1	18.0

Table 6. Positions of characteristics of biochemical composition of fruits of *Vacciniaceae* species in a row of strengthening of inter-seasonal distinctions in the parameters of their accumulation

Chemical composition	*V. corymbosum L.*	*V. vitisidaea* L.,	*Oxycoccus macrocarpus* (Ait.) Pers.
Dry matter	1	3	2
Organic acid	23	14	19
Vitamin C	20	26	1
Glucose	7	2	12
Fructose	27	18	30
Sucrose	31	28	22
Total sugar	22	10	24
Fructose/ Glucose ratio	25	21	32
Monose/Disaccharide ratio	30	30	26
Sugar-acid index	28	22	28
Hydropectin	13	6	7
Protopectin	17	11	16
Total pectins	12	4	9
Protopectin/Hydropectin ratio	19	17	23
Anthocyanins	32	32	27
Leucoanthocyanins	24	25	18
Total anthocyanic pigments	29	27	17
Catechines	21	29	25
Flavonols	3	16	29
Flavonols/Catechines ratio	26	31	31
Total bioflavonols	2	15	20
Chlorogenic acids	9	23	15
Benzoic acid	5	19	11
Tannins	18	20	5
Lignins	4	5	10
Fixed oils	16	8	3
Triterpene acids	10	12	21
Nitrogen	15	1	6
Phosphorus	8	9	4
Potassium	14	24	14
Calcium	6	7	8
Magnesium	11	13	13

At the same time specific features of the variability were inherent to each cultivars of *Vacciniaceae* species even within the limits of exact area of its gradation. For revealing sequence of analyzed traits in ascending order a level of their variability in a long-term cycle of the supervision, specifying on strengthening of inter-seasonal distinctions, it has been decided to position each of traits according to increase in values of the variation coefficients (Table 6). It is apparent from the data that the least expressive inter-seasonal distinctions at *V. corymbosum L.* are established for the contents in fruits of dry matter, of flavonols and of total bioflavonoid, of lignins and of benzoic acid, whereas the most expressive ones are established are anthocyanins, total anthocyanic pigments, sucrose, monose to disaccharide ratio and also the sugar-acid index. The least expressed inter-seasonal distinctions at *V. vitis-idaea* L. cultivars are nitrogen, glucose, dry matter and pectin, and also lignins, whereas the most expressed ones are anthocyanins, catechines, sucrose, ratio of bioflavonoid fractions, and also monose to disaccharide ratio. The least significant inter-seasonal distinctions in *Oxycoccus macrocarpus* (Ait.) Pers. cultivars are vitamin C, fixed oils, phosphorus, of the dry matter is tannins, whereas the most significant ones are fructose, flavonols, ratio of bioflavonoid fractions, monose to disaccharide ratio, and also values of the sugar-acid index.

Biochemical composition of fruits of the majority of early-maturing cultivars of blueberry has higher stability to a hydrothermal regime of a season, than the mid-ripening and late-ripening cultivars. Thus the biochemical composition of fruits of the 4 early-maturing cultivars such as *Reka*, *Puru*, *Nui* and *Duke* are the most steady, surpassing the zoned *Bluetta* cultivar. The least steady in this respect are *Spartan* and *Northblue* cultivars.

At the same time among mid-ripening cultivars of *Vaccinium corymbosum L.* the zoned *Bluecrop* cultivar is characterized by the least dependence on weather factors. Among the others of mid-ripening cultivars of a blueberry, the *Patriot* cultivar has the most expressed stability. *Toro* and *Jersey* cultivars were characterized by the least stability. The two late-ripening cultivars (*Coville* and *Elizabeth*) have the least steadiness.

In a cultivar row of *Vaccinium vitis-idaea* L. *Ammerland, Rubin* and especially *Red Pearl* were characterized by the greatest stability of biochemical composition of fruits. The zoned *Koralle*. *Masovia* and *Erntekrone* are characterized by the least stability of this trait.

Among taxons of *Oxycoccus macrocarpus* (Ait.) Pers. *Ben Lear* cultivar were characterized by the most steadiness of biochemical composition of fruits to external influences and *Stevens* were characterized by the least one of this trait.

Conclusion

As a result of comparative research of levels of variability of 32 quantitative characteristics of biochemical composition of fruits of 30 taxons of 3 *Vacciniaceae* species (*V. corymbosum L.*, *V. vitis-idaea* L. and *Oxycoccus macrocarpus* (Ait.) Pers.) in a long-term cycle of supervision, it has been established, that the *Oxycoccus macrocarpus* (Ait.) Pers. characterizes by the most expressed stability of biochemical composition of fruits to complex influence of abiotic factors.

The least expressive inter-seasonal distinctions in the biochemical composition of dry matter of fruits of highbush blueberry are flavonols and total bioflavonoid, lignins and benzoic acid, whereas the most expressive ones are anthocyanins, total anthocyanic pigments, sucrose, monose to disaccharide ratio, and sugar-acid index. The least expressed inter-seasonal distinctions in biochemical composition of dry matter of fruits of lingonberries are nitrogen, glucose, lignins and pectin, whereas the most expressed ones are anthocyanins, atechines, sucrose, ratio of bioflavonoid fractions and monose to disaccharide ratio. The least significant inter-seasonal distinctions in biochemical composition of dry matter of fruits of cranberry are vitamin C, fixed oils, phosphorus, tannins, whereas the most significant ones are fructose, flavonols, ratio of bioflavonol fractions, monose to disaccharide ratio and sugar-acid index.

The majority of early-maturing cultivars of a highbush blueberry have higher stability of biochemical composition of fruits to the hydrothermal regime of a season, than the mid-ripening and late-ripening cultivars. Thus, the biochemical composition of fruits of the 4 early-maturing cultivars such as *Reka*, *Puru*, *Nui* and *Duke* are the most steady, surpassing the zoned *Bluetta* cultivar. The least steady biochemical composition of fruits hasbeen observed in *Spartan* and *Northblue* cultivars. Among mid-ripening cultivars of highbush blueberry the zoned *Bluecrop* and *Patriot* show dependence on weather factors. *Toro* and *Jersey* cultivars have the least stability of biochemical composition of fruits, differing from the two late-ripening *Coville* and *Elizabeth* being the least steady.

In a cultivar row of *Vaccinium vitis-idaea* L. *Ammerland*, *Rubin* and especially *Red Pearl* were characterized by the greatest stability of biochemical composition of fruits in a long-term cycle of supervision, surpassing the zoned *Koralle*. *Masovia* and *Erntekrone* were characterized by the least stability in this regard.

Among taxons of *Oxycoccus macrocarpus* (Ait.) Pers. *Ben Lear* cultivar is the most steady to external influences and zoned Stevens is the least one.

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