

INFLUENCE OF ROOTSTOCKS ON THE PRODUCTIVITY AND CHEMICAL COMPOSITION OF *PRUNUS DOMESTICA* L. FRUITS

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ABSTRACT

The influence of seedling and clonal rootstocks of different spreads on *Prunus domestica* L. plum fruits quality and productivity of Yaichnaya Sinyaya and Utro varieties was studied. The significant change of productivity and the fruit weight of the varieties under study was to determine under the influence of the rootstock. Depending on the scion-stock combination the plum tree's productivity varied from 7.5 kg/tr. (Utro/140-1) to 15.1 kg/tr. (Yaichnaya Sinyaya /Novinka) at the mean value of 11.5 kg/tr. Medium-growing rootstocks Novinka and OPA-15-2 provided the maximum value of the varieties productivity. The significant productivity decrease relatively to seedling rootstock was stated for the combinations with low-growing rootstock 140-1. Soluble solids content in the fruits of Yaichnaya Sinyaya variety is higher than in the fruits of Utro variety, moreover, the highest values were determined on Novinka and OPA-15-2 rootstocks: on 4 – 4.5% higher in comparison with the fruits on the seeding rootstock at average. The rootstock causes less influence on titratable acids. The antioxidant activity of Yaichnaya Sinyaya variety fruits is 30% higher than that of Utro variety fruits on average. The maximum values of antioxidant activity in Yaichnaya Sinyaya variety fruits were fixed on OPA-15-2 rootstock (16.37%), the minimal ones – on Skorospelka Krasnaya rootstocks (14.68%). In the fruits of Utro variety the highest values were stated on OP-23-23 rootstock (13.16%), and the lowest ones – on the seedling rootstock (10.93%). The content of phenolic compounds sum is 60% higher in the fruits of Yaichnaya Sinyaya variety than in Utro variety ones on average. The decrease of the content of phenolic compounds sum was stated in the fruits of Utro variety on all the rootstocks in comparison with the combination Utro/seedling rootstock. The decreasing series of ash elements accumulation ($K > P > Ca > Mg > Mo > S > Zn > Si$) was determined. The strongest variety differences on total mineral element content were overvalued on medium-growing clonal rootstocks (Novinka, OP-23-23 and OPA-15-2). OPA-15-2 and OP-23-23 rootstocks provided the highest fruit quality on the combination of economic and biochemical parameters.

Keywords: *Prunus domestica* L; scion-stock combinations; productivity; fruits chemical composition

INTRODUCTION

The popularity of domestic plum (*Prunus domestica* L.) in different horticultural zones of Russia is connected with ecological plasticity, winter resistance, early maturity, and stable productivity of cultivated varieties (Upadysheva, 2015; Eremin and Brizhinov, 2011). New clonal stocks are used to duplicate new valuable varieties of fruit crops and to create intensive plantations because they favorably influence on adaptivity, early maturity, and productivity of grafted plants (Upadysheva, 2017; Eremin et al., 2000). The spread, the start of fruiting, and the productivity of grafted plants depend on the rootstock (Blazek and Pistekova, 2012; Hatton et al., 2015).

Fruits quality is a genetically associated character for each variety, but in the scientific literature there are data about the significant influence of a rootstock on the weight

and quality of fruits (Usenik et al., 2010; Orazem, Stampar, Hudina, 2011; Bartolini et al., 2014; Reig et al., 2018; Iglesias et al., 2019; Radovića et al., 2020; Karakaya et al., 2021).

Seedling rootstocks (seedlings of domestic plum and alucha) and clonal ones of different growing spread (strong-growing – 13-113, medium-growing – OPA-15-2, OP-23-23, SVG-11-19 and Novinka and low-growing – 140-1, VVA-1) are used for plums cultivation in the Central region of Russia (Eremin, 2000). Many questions devoted to plum varieties propagation and scion-stock combination selection are successfully solved in the world; at the same time, the life length of grafted plants and the harvest quality depending on a variety and a rootstock are not studied enough.



Figure 1 The garden of intensive type during blossoming.



Figure 2 The plum fruits: Yaichnaya Sinyaya (on the left) and Utro (on the right).

The major part of the researches of the biochemical composition of plum fruits scion-stock combinations was connected with the rootstock influence on the content of soluble solids and titratable acids in the fruits (Daza et al., 2008; Rato et al., 2008; Reig et al., 2018).

The main component of plum fruits' chemical composition is minerals. Among them, K, P, Mg, and Ca are found in big quantities, whereas other minerals such as Fe, B, Cr, Mn, Cu, and Zn are present in much fewer quantities (Cosmulescu et al., 2017). The mineral composition changes and the content of bioactive

compounds in fruits *Prunus domestica* L. depending on the rootstock were practically understudied. In scientific literature, the data about the stock influence on the leaves mineral composition are only presented (Meland, 2010; Milošević and Milošević, 2011; Ionica et al., 2013; Reig et al., 2018). The accurate forecast of plum scion-stock combinations germinability and productivity and the stock influence on the nutrients and bioactive substances accumulation in plum fruits is very important for the output yield of high quality.

That is why this work aimed to determine the influence of different growing strength rootstocks on the fruits chemical composition and productivity of the domesticated plum varieties bred by Horticulture. 2 Federal State Budget Scientific Institution «Federal Scientific Selection and Technological Center of Horticulture and Nursery Breeding» (Federal Horticultural Research Center).

Scientific hypothesis

The domesticated plum (*Prunus domestica* L.) fruits productivity and quality, their biological composition depending on the used rootstocks are not studied enough. We have checked the influence of the strong-growing seedling and medium and low-growing clonal rootstocks on the fruit productivity, quality, and nutritional value of the plum varieties, i.e. Utro and Yaichnaya Sinyaya grown in Moscow region conditions. We supposed that on the base of the field and laboratory experiments the optimal stock for each variety that will provide the high productivity and valuable bioactive substances accumulation in the plum fruit will be found.

MATERIAL AND METHODOLOGY

Conditions of plant growing

The field researches were held in 2018 – 2019 on the experimental *Prunus domestica* L. plantations, located at laboratory plot of Federal Horticultural Research Center

for Breeding, Agrotechnology and Nursery in Moscow region (55° 56' of North latitude, 37° 64' East longitude). The plantation overall area was 0.5 ha. The garden of intensive type was set out in 2010 using the scheme 5 x 2.5 m. The soil in the row spacing was black fallow (Figure 1).

Biological material

The fruits of Utro and Yaichnaya Sinyaya varieties on 6 stocks, i.e. strong-growing *P. domestica* L. seedlings, medium-growing clonal rootstocks Skorospelka Krasnaya (*Prunus domestica* L.), Novinka (*Prunus bessyi* L.H. Bailey x *Prunus ussuriensis* Kovalev& Kostina), OP-23-23 (*Prunus pumila* L. x *Prunus salicina* Lindl. x *Prunus persica* Stokes), OPA-15-2 (*Prunus pumila* L. x *Prunus salicina* Lindl. x *Prunus cerasifera* Ehrh) and low-growing clonal rootstock 140-1 (*Prunus bessyi* L.H. Bailey x *Aflantonia ilmifolia* L.) were the object of the scientific studies. The samples were taken at the ripeness stage (Figure 2).

The biochemical studies were held in the laboratory of biochemistry and physiology of Federal Horticultural Research Center for Breeding, Agrotechnology, and Nursery.

Chemicals

All chemical substances chosen for the analysis were of an analytical sort and were bought from Sigma Aldrich (USA).

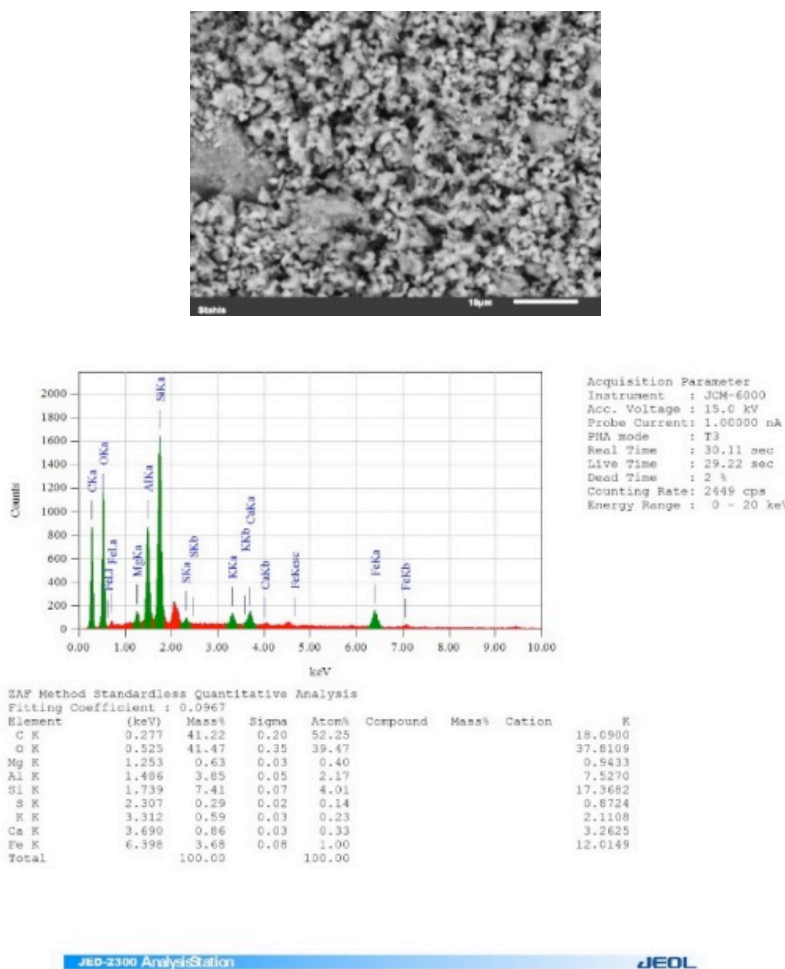


Figure 3 ESD-analysis protocol.

Sample preparation

From representative not less than 500 g fruits probe, 300 g of fruit without stone were prepared. The mass was homogenized using the analytical homogenizer IKA A11 basic (Germany). Then it was extracted by double distilled water (to determine antioxidant activity and phenol compounds sum) and by pure methanol (to study the metabolites composition) and centrifugated at 4000 g (Sigma, Germany) within 10 min. The supernatant was used for measurement purposes. We performed all extractions in triplicate independent samples.

Basic chemical analyses

General biochemical parameters, i.e. soluble solids content (SSC) and total titratable acidity (TTA). SSC was determined via refractometric method according to (GOST ISO 2173, 2013), the values were expressed in %. TTA was estimated via the potentiometric method by pH meter HI 2211 HANNA (Germany) via titrating with 10 N. NaOH and expressed in the equivalent of apple acid, % (GOST ISO 750, 2013).

Total phenolic compounds analysis

The total phenolics amount was determined with Folin–Ciocalteu reagent according to the method described by Velioglu et al. (1998). A standard curve with gallic acid was used. Different concentrations of gallic acid were prepared in distilled water, and absorbance was recorded at 750 nm. 100 µL of the diluted sample (1:10) was dissolved in 500 µL of Folin–Ciocalteu reagent and 1000 µL of distilled water. The solutions were mixed and incubated at room temperature for 1 min. After 1 min, 1500 µL of 20% sodium carbonate (Na₂CO₃) solution was added. The final mixture was shaken and then incubated for 2 h in the dark at room temperature. The absorbance was measured at 750 nm using a Helios Y UV–vis spectrophotometer and the results are expressed in mg of gallic acid (GEA) calculated on the wet weight of plants.

Total antioxidant capacity

The scavenging activity on the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical was determined spectrophotometrically according to the method described by Brand-Williams et al. (1995). The principle of the analysis was based on the colour change of DPPH solution from purple to yellow as the radical was quenched by antioxidants. The homogenized leaves were mixed with distilled water and methanol. The samples were put on the shaker Lab-PU-01 (Russia) for 6 hours, and then they were filtered and the antioxidant activity was measured in 10 minutes after interaction between the extract and the reagent. The absorbance was recorded at 517 nm to determine the concentration of the remaining DPPH. All measurements were performed in triplicate. The radical-scavenging activity was calculated as a percentage as follows:

$$\text{DPPH radical-scavenging (\%)} = [(AC - AAt) / AC] \cdot 100,$$

Where:

AC – DPPH solution absorption; AAt – absorption at the antioxidant presence.

The lower absorbance of the reaction mixture indicates a higher level of free radical scavenging activity.

EDS - analysis

The chemical composition of the basic ash components (Mg, Si, P, S, K, Ca, Zn, Mo) was determined by the method of energy dispersive spectrometry (ESD) on the analytical raster electron microscope JEOL JSM 6090 LA according to the methodology (Motyleva, 2018).

X-ray microanalysis data are presented in the form of standard protocols which contain the microstructure picture of the sample under study, the table of the data in weighting and atomic correlation, spectra, and histograms presented in Figure 3.

Metabolic analysis by gas chromatography-mass spectrometry

The metabolites analysis was fulfilled using the method of gas chromatography-mass spectrometry (GC-MS) via GCMS chromatograph JMS-Q1050GC («JEOL Ltd», Japan). Capillary column DB-5HT (Agilent, USA); length 30 m, inner diameter – 0.25 mm, the film thickness – 0.52 µm, and gas-carrier — helium) was used. The temperature gradient during the analysis was within 40 – 280 °C, the injector and interface temperature – 250 °C, the ionic source – 200 °C. Gas flow in the column was equal to 2.0 mL·min⁻¹, split-flow injection mode, sample injected in volume 1 – 2 µL of the evaporated extract. The analysis was held for 45 min. The derivation was held using silylation reagent N,O bis (trimethylsilyl) trifluoroacetamide (BSTFA) following the method described by Robbins (2003). The substances identification was done according to NIST-5 National Institute of Standards and Technology (USA) retention behavior and mass spectra the scanning range was 33 – 900 m/z. The substance identification credibility was within 75 – 98%.

Number of repeated analyses: 3

Number of experiment replication: 2

Statistical analysis

All the analyses were performed in triplicate. The results were expressed as mean values (n = 3) in standard deviation (SD). Statistical analyses were carried out through the Excel package (Microsoft Excel, v. 2016).

RESULTS AND DISCUSSION

We studied the plum trees' productivity of different scion-stock combinations in the field conditions, determined the fruit average weight, fulfilled the fruits organoleptic and degustation estimation. As a result of our studies, it was stated that during 2018 – 2019 the plum tree's productivity was 11.5 kg/tree on average, and depending on scion-stock combination it changed from 7.5 kg/tree (Utro/140-1) to 15.1 kg/tree (Yaichnaya Sinyaya/Novinka). This parameter was above average at the understudied varieties grafted on medium-growing clonal rootstocks Novinka and OPA-15-2. The minimum parameters were stated at the combinations with low-growing rootstock 140-1 (Table 1).

The rootstock influence on *P. domestica* L. productivity is discussed in the papers (Ciobanu et al., 2009; Kaufmane et al., 2007; Popova et al., 2020).

Studied varieties belong to large-fruited ones with fruits weight more than 30 g. The Utro variety's average fruit weight is 31.2 g, but depending on the stock it varied from

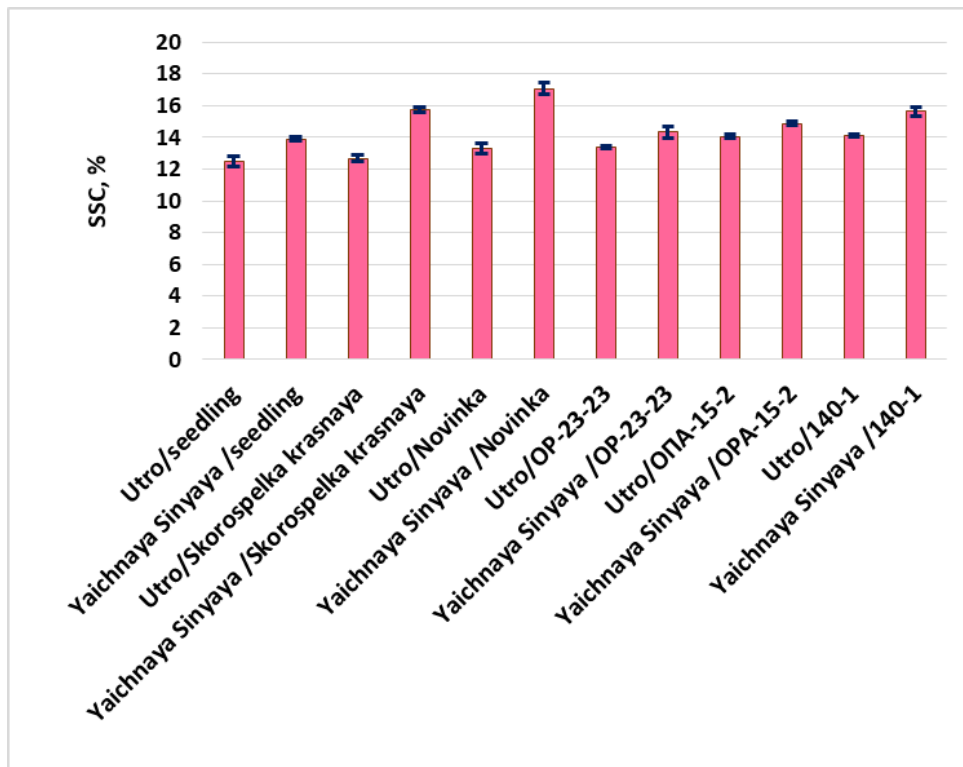


Figure 4. Soluble solids content in *Prunus domestica* L. fruits depending on the stock at average in 2018 – 2019; each value represents the mean of three independent experiments ($\pm SD$).

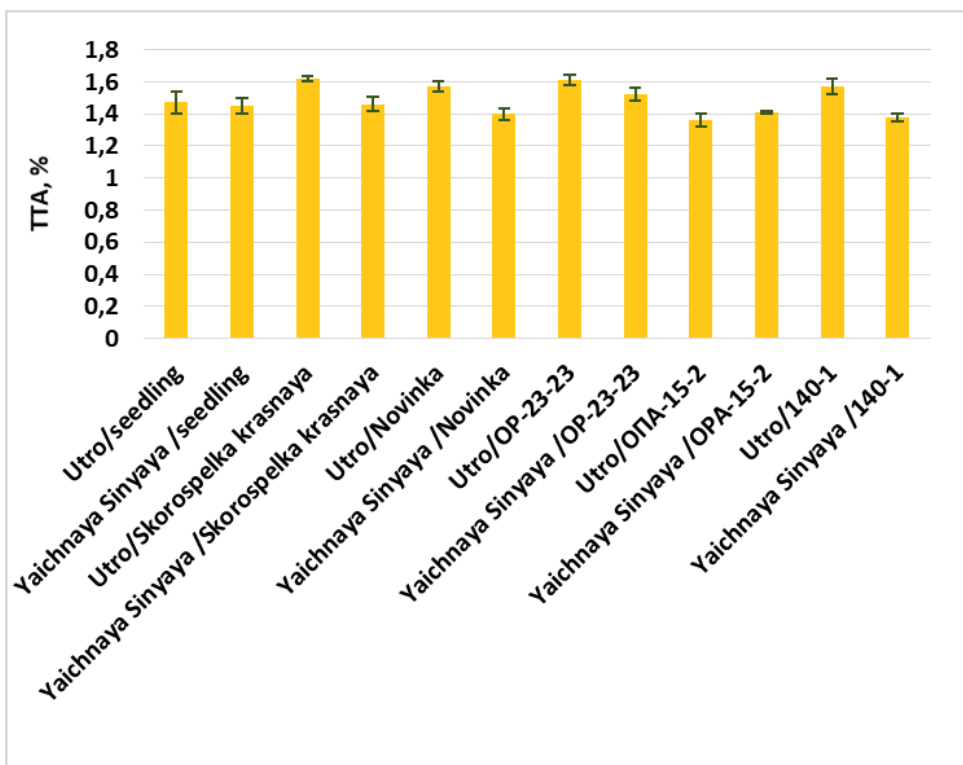


Figure 5 Titratable acidity content in plum fruits of *Prunus domestica* L. depending on the stock at average in 2018– 2019; each value represents the mean of three independent experiments ($\pm SD$).

29.7 g (seedlings *P. domestica* L.) to 33.8 g (OP-23-23). The understudies varieties fruits were significantly larger under OP-23-23 rootstock influence. The Utro variety fruit stone was separated from the flesh well, its portion in the fruit weight was 6% on average with variation from 5.7% (Novinka) to 6.5% (seedlings *P. domestica* L.).

The Yaichnaya Sinyaya variety fruit stone was larger and was near 7% of the fruit weight for all the combinations, it separated from the fruit flesh well. According to the degustation results, the understudied varieties of fruits were characterized with balanced sour-sweet taste and smell (4.2 – 4.8 scores). The degustation estimation had

Table 1 The productivity, fetal mass and organoleptic estimation of *Prunus domestica* L. fruits depending on the stock at average in 2018 – 2019.

Scion/rootstock combinations	Productivity (kg/tree)	Average fruit weight(g ±SD)	Degustation estimation, point
Utro/140-1	7.5±0.85	30.8±0.61	4.6
Utro/Novinka	14.6±2.11	29.7±0.44	4.6
Utro/OPA-15-2	14.9±2.07	30.3±0.64	4.8
Utro/OP-23-23	11.9±1.74	33.8±0.73	4.7
Utro/ Skorospelka Krasnaya	11.8±1.17	32.7±0.87	4.5
Utro/ seedlings <i>P. domestica</i>	11.3±1.65	29.7±0.65	4.2
Yaichnaya Sinyaya/140-1	8.2±0.87	32.1±0.68	4.7
Yaichnaya Sinyaya/Novinka	15.1±2.69	31.3±0.67	4.7
Yaichnaya Sinyaya/OPA-15-2	13.1±1.13	32.1±0.75	4.8
Yaichnaya Sinyaya/OP-23-23	8.7±0.74	33.4±0.61	4.8
Yaichnaya Sinyaya/Skorospelka Krasnaya	10.7±0.95	32.4±0.65	4.6
Yaichnaya Sinyaya/seedlings <i>P. domestica</i>	10.1±0.99	32.2±0.53	4.6

Table 2 The rootstock influence on *Prunus domestica* L. fruits antioxidant activity (AA) and phenolic compounds (PC) sum; the values represent the mean of three replicate ±SD.

Scion/rootstock combinations	AA, %	PC, mg gallic acid (GEA)/1g fruit weight
Utro/seedlings <i>P. domestica</i>	10.93 ±0.174	0.99 ±0.032
V, %	2.77	5.35
Utro/Skorospelka Krasnaya	13.90 ±0.967	0.43 ±0.041
V, %	7.25	8.78
Utro/Novinka	11.38 ±0.254	0.22 ±0.049
V, %	3.76	17.82
Utro/OPA-15-2	11.33 ±0.239	0.43 ±0.024
V, %	2.08	8.73
Utro/140-1	12.90 ±0.181	0.46 ±0.018
V, %	2.48	6.27
Utro/seedlings <i>P. domestica</i>	16.25 ±0.055	0.70 ±0.006
V, %	0.58	1.41
Yaichnaya Sinyaya/Skorospelka Krasnaya	14.68 ±0.648	0.94 ±0.024
V, %	7.25	4.21
Yaichnaya Sinyaya/Novinka	15.20 ±0.118	0.53 ±0.029
V, %	1.33	9.43
Yaichnaya Sinyaya/OP-23-23	15.39 ±0.105	0.43 ±0.025
V, %	1.17	0.68
Yaichnaya Sinyaya/140-1	16.58 ±0.69	0.91 ±0.038
V, %	0.98	6.69

the maximum score at Utro/OPA-15-2 and Yaichnaya Sinyaya/OP-23-23 combinations (). The soluble solids content (SSC), total titratable acidity (TTA), antioxidant activity (AA), phenolic compounds (PC) sum, and mineral composition change of the understudied plum varieties fruits on different rootstocks were studied in laboratory conditions.

Depending on the variety and the rootstock SSC in the fruits varied from 12.72% (Utro/Skorospelka Krasnaya) to 17.48% (Yaichnaya Sinyaya/Novinka). In the Utro variety fruits on Novinka, OPA-15-2 and 140-1 rootstocks SSC was on 1 – 1.3% higher in comparison with the fruits on the seedling (Figure 4). In the Yaichnaya Sinyaya variety fruits, SSC was higher than in the Utro variety ones; SSC maximum values were determined on Novinka, Skorospelka Krasnaya, and OPA-15-2 rootstocks, i.e. on 4 – 4.5% higher than in the fruits on the seedling at average.

In the understudied scion-stock combinations samples TTA varies within the range 1.1 – 1.7% (Figure 5).

The Yaichnaya Sinyaya variety TTA depended on a scion-stock combination a little. The maximum TTA content was noted at the fruits of Utro variety on Skorospelka Krasnaya, Novinka, OP-23-2,3 and 140-1 rootstocks (1.6 – 1.7%). Lopez-Ortega et al. (2016) informed that between the stocks there was no significant difference in SSC accumulation. However, Gonçalves et al. (2006) and Usenik et al. (2010) found out that at sweet-cherry trees the rootstock influenced SSC and at dwarfing rootstocks SSC was higher. Besides, in the papers of Daza et al. (2008) and Rato et al. (2008), it was stated that at plum trees a rootstock affected such quality features as SSC and TTA. While studying the rootstock influence on *Prunus rossica* Erem. Fruits, it was noticed that a rootstock influenced SSC, but did not affect TTA greatly (Motyleva et al., 2019).

Table 3 The ash composition of Utro variety fruits on different rootstocks.

Scion/rootstock combinations	The understudied element, mass%								
	Mg	Si	P	S	K	Ca	Zn	Mo	Σ
Utro/Skorospelka Krasnaya	2.09	0.12	3.46	0.34	27.77	3.29	n/o	2.11	39.18
Utro/Novinka	1.95	0.04	4.34	0.15	28.30	1.53	0.45	1.49	38.25
Utro/OP-23-23	1.37	0.07	2.69	0.18	26.84	1.14	0.62	1.37	34.28
Utro/OPA-15-2	1.83	0.08	3.68	0.23	30.76	1.04	0.46	1.75	39.83
Utro/140-1	1.88	0.29	4.16	0.11	28.95	1.26	0.25	1.15	38.05
Utro/seedlings <i>P. domestica</i>	1.76	0.11	3.29	0.16	29.73	1.34	0.17	1.42	37.98
Min	1.37	0.04	2.69	0.11	26.84	1.04	0.17	1.15	
Max	2.09	0.49	4.34	0.34	30.76	3.29	0.62	2.11	
V, %	12.5	35.9	15.7	38.6	4.9	18.8	39.6	19.7	

Table 4 The ash composition of Yaichnaya Sinyaya variety fruits on different rootstocks.

Scion/rootstock combinations	The understudied element, mass%								
	Mg	Si	P	S	K	Ca	Zn	Mo	Σ
Yaichnaya Sinyaya/ OPA-15-2	1.13	0.06	3.39	0.29	25.94	0.45	0.42	0.99	32.67
Yaichnaya Sinyaya/ OP-23-23	1.30	0.18	4.63	0.18	27.91	0.72	0.48	1.23	36.63
Yaichnaya Sinyaya/ Skorospelka Krasnaya	1.55	0.13	3.90	0.15	30.14	1.19	0.38	1.45	38.89
Yaichnaya Sinyaya/ seedlings <i>P. domestica</i>	0.88	0.16	2.96	0.06	18.99	0.62	0.19	1.19	25.05
Yaichnaya Sinyaya / Novinka	0.81	0.10	2.90	0.11	20.72	0.73	0.29	0.83	26.49
Yaichnaya Sinyaya / 140-1	1.70	0.11	4.23	0.37	26.60	0.28	0.29	2.90	36.48
Min	0.81	0.06	2.9	0.06	18.99	0.28	0.19	0.83	
Max	1.7	0.18	4.63	0.37	30.14	1.19	0.48	2.9	
V, %	26.1	35.0	19.1	30.0	7.2	16.6	30.7	12.4	

Table 5 The comparative content of the main compounds, found in Yaichnaya Sinyaya variety on different rootstocks, % scale.

Substances	Yaichnaya Sinyaya/rootstocks					
	Seedling Prunus	Skorospelka Krasnaya	Novinka	OP-23-23	OPA-15-2	140-1
10:02 L-Norleucine	18	15	9	18	10	1
10:30 Succinic acid	9	5	4	4	5	<1
10:53 Fumaric acid	30	30	28	27	17	1
11:19 Malic acid	8	50	40	40	40	11
11:34 Malonic acid	8	8	43	40	5	14
16:06 Levoglucosan	4	22	28	11	8	4
16:35 D-(-)-Fructofuranose	70	75	80	80	80	75
17:03 D-Allofuranose	25	10	40	25	20	20
17:07 Quinic acid	80	85	94	90	95	20
17:27 b-D-Glucopyranose	70	92	90	80	90	90
17:41 Acrylic acid	10	25	32	7	5	8
17:51 D-Sorbitol	25	30	30	50	38	40
18:23 D-Glucose	70	75	70	88	75	40
17:59 D-(+)-Talofuranose	1	2	10	12	10	40
19:15 Myo-inositol	18	17	12	17	20	10
24:18 Sucrose	90	95	92	92	90	90

Widely spread substances-antioxidants, contained in plants, belong to different classes of chemical compounds. They play a significant role in human nutrition as protective factors that decrease the risk of various diseases (Fazzari et al. 2008; Usenik et al., 2008). These bioactive compounds concentration varies depending on different factors, i.e. climate, soil, rootstocks (Spinardi et al. 2005), сорта (Mozetic, Trebse and Hribar, 2002; Usenik et al. 2008).

Our study results confirm the rootstock influence on bioactive substance synthesis in *Prunus domestica* L fruits. The antioxidant activity of Yaichnaya Sinyaya variety fruits is 30% higher than Utro variety fruits on average (Table 2). The maximum AA values are determined in Yaichnaya Sinyaya variety fruits on the rootstocks OPA - 15-2 (16.37%) and 140-1 (16.58%), and the minimal ones – on Skorospelka Krasnaya rootstock (4.68%). The highest AA values in Utro variety fruits were registered on Skorospelka Krasnaya (13.9%) and OP-23-23 (13.16%) rootstocks, and the lowest ones – on the seedlings (10.93%).

PC content in Yaichnaya Sinyaya variety fruits was 60% higher than in Utro variety ones on average (Table 2). The maximum PC content was registered in Yaichnaya Sinyaya variety fruits on Skorospelka Krasnaya and 140-1 rootstocks, i.e. 0.94 and 0.91 mg.g⁻¹ of the fruits equivalent of gallic acid relatively, and the minimum PC content were stated on OP-23-23 rootstock, i.e. 0.43 mg.g⁻¹ of the fruits equivalent of gallic acid.

In Utro variety fruits on all the rootstocks, the decrease of PC sum content was stated in comparison with Utro/seedling combination, and on Skorospelka Krasnaya, OPA-15-2, and 140-1 rootstocks the content was twice less.

The mineral substances are an important component of human nutrition, they are a part of enzymes and have antioxidant activity; they are not synthesized in the human organism, but get inside it only with meals. Eight main elements, i.e. Mg, Si, P, S, K, Ca, Zn, Mo, were determined in the plum fruits. K is the main element in the plum fruits. Its content varied from 26.84 mass % (Utro/OP-23-23) to 30.76 mass % (Utro/OPA-15-2) (Table 3). K content variation coefficient is low (4.88%) that speaks about the insignificant influence of the rootstock on this element accumulation.

P content varied within the range from 2.69 mass % (Utro/OP-23-23) to 4.34 mass % (Utro/Novinka). P content variation coefficient is 16.7%, which speaks about a stable input of this element in plum fruits.

The portion of Ca in Utro variety fruits is from 1.04 mass % (Utro/OPA-15-2) to 3.29 mass % (Utro/Skorospelka Krasnaya). This element variation coefficient is medium. The portion of Mn and Mo in plum fruits does not exceed 2.1 mass %, these elements maximum accumulation is registered in Utro/Skorospelka Krasnaya combination, i.e. 2.09 and 2.11 mass % relatively. Mn variation coefficient is low, i.e. 13.49%, and Mo coefficient is medium, i.e. 21.74%.

Si maximum accumulation is registered in Utro/140-1 combination fruits, i.e. 0.29 mass %.

Zn content varied from 0.17 mass % (Utro/seedlings) to 0.62 mass % (Utro/OP-23-23). The highest values of all the elements sum are registered in Utro/Skorospelka

Krasnaya (39.18 mass %) and Utro/OPA-15-2 (39.83 mass %) scion-stock combinations.

In Yaichnaya Sinyaya variety fruits K is accumulated on 4% less than Ca and twice less than Ca than in Utro variety fruits (Table 4).

The content of Mg, P, S, K, and Zn on all the rootstocks is higher than on seedlings. Among all the scion-stock combinations we can distinguish the fruits of the following combinations on all the elements sum content: Yaichnaya Sinyaya/OP-23-23 (36.63 mass %), Yaichnaya Sinyaya/140-1 (36.48 mass %), and Yaichnaya Sinyaya/Skorospelka Krasnaya (38.89 mass %).

Significant differences in mineral elements sum content were determined in the fruits between the varieties and the scion-stock combinations of varieties and rootstocks. The greatest differences in the mineral substances sum content were registered on the medium-growing clonal rootstocks Novinka, OP-232-23, and OPA-15-2.

Higher accumulation of Ca, Mg, and K were determined in the fruits of both varieties on Skorospelka Krasnaya rootstock in comparison with other rootstocks. The decreasing series of the accumulation of the elements in plum fruits is as follows: K > P > Ca > Mg > Mo > S > Zn > Si.

The data given in the scientific literature about the mineral element content in plum fruits are limited, especially regarding the influence of the rootstock. The results on the content of K, Ca, P, and Mg, Mn, Cu, and Zn are presented in the papers of Rop et al. (2009), Cosmulescu et al. (2017), Milosevic and Milosevic (2012) and Motyleva, Upadysheva and Tumaeva (2021).

K, Ca, and P values received by us as a result of this study correlate to the data given in the scientific literature in a proportional relation. The differences for some elements content can be connected with the environmental conditions, such as the soil type, the precipitation depth, and the fertilizers application (Kabata-Pendias, Mukherjee and Trace, 2007).

The component composition of plum fruits methanol extracts is illustrated by Yaichnaya Sinyaya variety (Table 5). The main components of plum fruits metabolomic profiles are 16 individual chemical compounds, i.e. L-Norleucine, Succinic acid, Fumaric acid, Malic acid, Malonic acid, Levoglucosan, D-(-)-Fructofuranose, D-Allofuranose, Quinic acid, b-D-Glucopyranose, Acrylic acid, D-Sorbitol, D-Glucose, D-(+)-Talofuranose, Myo-inositol, Sucrose, 9 of which are carbohydrates and their derivatives. The main carbohydrates are saccharose, glucose and fructose. Rootstocks influence the ratio of the metabolite (Table 5). On the medium-growing rootstocks, we registered the increase of monosaccharides on 5 – 7%, Quinic acid on 3 – 5%, and Myo-inositol on 2.5 – 3% in comparison with strong- and low-growing rootstocks. The high biological role of Quinic acid and Myo-inositol as proved by many types of research (Akeson et al., 2005; Font i Forcada et al., 2019; Scăteanu et al., 2019). The maximum content of Quinic acid and Myo-inositol was marked in Yaichnaya Sinyaya variety fruits on OPA-15-2 rootstock. The same results were received during Utro variety fruits analysis.

CONCLUSION

The present study stated the rootstock influence on the plants' productivity and bioactive substances accumulation in *Prunus domestica* L. fruits. Under the influence of medium-growing rootstocks, i.e. OPA-15-2, Novinka, and OP-23-23, the increase of not only main economic parameters (output yield, the fruit size, and weight, sensor evaluation, SSC and TTA) but biologically important compounds (antioxidants, metabolites, macro, and microelements) was registered as well. The optimal rootstocks for Yaichnaya Sinyaya and Utro varieties are medium-growing rootstocks OPA-15-2, Novinka, and OP-23-23.

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Acknowledgments:

We would like to thank the researchers M. E. Mertvishcheva and D. V. Panishcheva for assistance in determining the titratable acidity, antioxidant activity and the amount of phenolic compounds.

Conflict of Interest:

The authors declare no conflict of interest.

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