

## BIOMETRICAL INDICATORS OF FRESH FRUITS OF BULGARIAN AND INTRODUCED PLUM CULTIVARS OF *PRUNUS DOMESTICA* L.

STELA DIMKOVA\*; DARINA IVANOVA; SILVENA TODOROVA; NIKOLINA MARINOVA  
 Agricultural Academy, Research Institute of Mountain Stockbreeding and Agriculture – Troyan, 5370 Branch – Dryanovo

### Abstract

Dimkova, S., D. Ivanova, S. Todorova and N. Marinova, 2017. Biometrical indicators of fresh fruits of Bulgarian and introduced plum cultivars of *Prunus domestica* L. *Bulg. J. Agric. Sci.*, 23 (6): 947–950

The study was conducted in the period of 2014 – 2015 in the collection plantation at the Experimental Station of Dryanovo, Bulgaria. The object of study was fresh fruits of Bulgarian plum cultivars – ‘Gabrovska’, ‘Gulyaeva’, ‘Strinava’, ‘Balvanska slava’ and the introduced cultivars – ‘Opal’, ‘Ontario’, ‘Hramova renkloda’, ‘Althan’s Gage’, ‘Čačanska lepotica’. ‘Stanley’ was used as a standart cultivar. The following indicators were observed: fruit weight (g), stone weight (g), stone percentage in relation to fruit weight; fruit size – fruit length, fruit width and fruit thickness (mm); arithmetic mean diameter (mm); geometric mean diameter (mm); surface area (cm<sup>2</sup>); dry matter content (%). ‘Balvanska slava’ had the highest fruit weight – 37.24 g and ‘Opal’ had the lowest – 20.54 g ‘Opal’ had the lowest percentage of fruit stone in relation to fruit weight – 2.82%, and the highest value was for ‘Stanley’ cultivar – 4.91%. Fruit height was from 33.26 mm for ‘Opal’ to 47.80 mm for ‘Balvanska slava’. The largest width was found in ‘Althan’s Gage’ fruits – 41.02 mm, and the smallest width for ‘Opal’ – 30.40 mm. The fruit thickness was the largest again for ‘Althan’s Gage’ – 40.80 mm and the smallest thickness was for ‘Opal’ – 30.46 mm. It was found that dry matter content was the highest for ‘Gulyaeva’ cultivar – 21.94%, followed by ‘Strinava’ cultivar – 21.40%. The results show that the Bulgarian cultivars have very good fruit characteristics indicators, which are close to the popular introduced plum cultivars.

*Key words:* *Prunus domestica* L.; fruit size; fruit weight; stone weight

### Introduction

Plums are one of the most commonly consumed stone fruits in Bulgaria. It has been popular on account of its high productivity and it being less demanding with regard to soil conditions. Plums have low calorie content and relatively high nutritive value. This fruit is also rich in many minerals and vitamins ( C, A, B1, B2, PP ), essential for the appropriate functioning of the human organism.

It is found that over the past two decades there has been a reduction in areas occupied by fruit trees in Bulgaria. In 1980, the areas planted with plums were 23 300 ha (Vitanova et al., 2010), and in 2010, they were 7 489 ha (2011 – Bulletin № 176 of The BG Ministry and Agriculture and Food).

Plums are traditional for Bulgaria, but according to the Ministry of Agriculture and Food in 2014 (2015 – Bulletin № 281 and Bulletin № 289) they were on the third place in relation to areas after walnuts and cherries. The total production of plums and cherry plums in 2014 was 24 685 t, which was extremely low. All these data indicate that there are serious problems in that sector. According to Dzhuvinov (2000), the problems of Bulgarian fruit growing are related to changes in using and management of land, fragmentation of parcels, health status of planting material and the presence of a substantial proportion of old and fruitless plantations.

The main plum growing regions in Bulgaria are 4: Sredna Gora, East Balkan Mountains, West Balkan Mountains and the largest is the Central Balkan Mountain region (Vitanova et al.,

\*Corresponding author: steladim50@gmail.com

2010). With regard to cultivars, which are grown in the country, the most common is 'Stanley', followed by 'Green Gage', 'Althan's Gage', 'Čačanska leptotica', 'Čačanska najbolja', 'Gabrovska', 'Strinava' etc. (Vitanova et al., 2005; Vitanova and Dimkova, 2002; Dinkova and Dragoyski, 2005; Vitanova et al., 2011). As regards to perspective plum cultivars for Bulgaria, Iliev and Stoev (2010); Dragoyski et al. (2009); Vitanova et al. (2011) recommend the early cultivars: 'Ruth Gerstetter', 'Opal', 'Plum Californian Blue', 'Tuleu Timpuriu' and Bulgarian cultivars, such as: 'Gabrovska', 'Gulyaeva', 'Strinava' and 'Nevena', which have a later fruit ripening period. In plum tree plantations should be included cultivars with a different ripening period in order to provide the market with fresh plums for a longer time and to reduce the stress during harvesting time.

**The main aim** that we set in the present study is to expand and complement the data for the biometrical indicators of fresh fruits of Bulgarian and introduced plum cultivars of *Prunus domestica* L., with a view to complement their biological characteristics.

## Materials and Methods

The study was conducted at the Experimental Fruit Growing Station – Dryanovo (42° 59' 18" N; 25° 28' 46" E), Bulgaria, at an altitude of 306 m. The station is in the structure of Agricultural Academy – Sofia, Research Institute of Mountain Stockbreeding and Agriculture – Troyan. The observation was conducted in the period 2014–2015. Fresh fruits from 6 introduced plum cultivars were examined: 'Opal', 'Ontario', 'Hramova renkloda', Althan's Gage, 'Čačanska leptotica', 'Stanley' (control) and 4 Bulgarian cultivars: 'Gabrovska', 'Gulyaeva', 'Strinava' and 'Balvanska sliva', which were selected at the Experimental Fruit Growing Station in the town of Dryanovo. The plantation was established in 1999. The light

was forest grey, pseudopodzolic. The plantation is cultivated under non-irrigated conditions. The experimental trees were grafted on seedling rootstock – yellow cherry plum (*Prunus serasifera* Ehrh.). During the observation was followed the methodology for studying plant resources (Nedev et al., 1979). Some measurements were taken of an average sample from 20 fruits from each cultivar in the period of ripening stage, as the following biometrical indicators were determined: fruit sizes – length (mm), width (mm), thickness (mm). The arithmetic mean diameter was determined with the formulae:

$$Da = \frac{L + W + T}{3} \text{ mm,}$$

where  $L$  is the length of the fruit,  $W$  is the fruit width and  $T$  is the fruit thickness. The geometric mean diameter was calculated with the formulae:

$$Dg = \sqrt[3]{LWT} \text{ mm.}$$

The fruit surface was determined by the formulae:

$$S = \pi \cdot Dg^2 \text{ cm}^2,$$

where  $\pi = 3.14$ .

Fruit weight was reported (g) and the stone weight (g). The percentage of stone in relation to the fruit weight was estimated. The dry matter was examined refractometrically (%).

The statistical processing of some of the obtained data was made by the programme ANOVA by LSD test / Limited Standart Deviation / at  $\alpha = 0.05$ .

## Results and Discussion

The data obtained for the fresh fruit sizes of 10 plum cultivars are presented in Table 1. The table shows that fruits of 'Opal' cultivar have the smallest values of length, width and thickness; the smallest geometric and arithmetic diam-

**Table 1**  
**Size of fresh fruits of 10 cultivars, average for the period 2014-2015**

Cultivar	Average sizes, mm			Geometric mean diameter Dg, mm	Arithmetic mean diameter – Da, mm	Surface, cm <sup>2</sup>
	Length	Width	Thickness			
Stanley	46.21	35.55	35.74	38.87	39.17	47.43
Strinava	43.22	35.99	34.92	37.87	38.04	45.03
Gabrovska	42.76	33.82	31.68	35.78	36.09	40.20
Gulyaeva	42.03	35.02	34.12	36.89	37.06	42.74
Balvanska slava	47.8	38.18	37.86	41.03	41.28	52.87
Hramova renkloda	35.88	37.23	34.12	35.72	35.74	40.06
Opal	33.26	30.4	30.46	31.34	31.37	30.85
Ontario	37.78	35.84	36.45	36.68	36.69	42.24
Althan's Gage	38.42	41.02	40.8	40.06	40.08	50.39
Čačanska leptotica	44.55	36.72	36.46	39.07	39.24	47.93
$\alpha = 0,05$	LSD=1.91	LSD=1.78	LSD=1.56			

eter and thus the smallest fruit surface. Thus 'Opal' is distinguished as a cultivar with the smallest fruits from all 10 examined cultivars.

'Balvanska slava' cultivar is distinguished by the largest fruit surface – 52.87 cm<sup>2</sup>, and the largest geometric mean diameter – 41.03 mm and the largest arithmetic mean diameter – 41.28 mm.

According to the European standards for quality control of fresh fruit, all plums with a diameter of over 35 mm belong to 'Extra' quality (MAF, 2007).

The second place takes the fruit surface of 'Čačanska leptotica' (47.93 cm<sup>2</sup>), and on the third place was 'Stanley' (47.43 cm<sup>2</sup>).

The fruits of 'Althan's Gage' have spherical shape and are distinguished by the highest values of width and thickness, in relation to the other 9 cultivars, respectively 41.02 mm and 40.08 mm. Data on the fruit sizes (Table 1) give a good reason to place 'Althan's Gage' to the group of the large-sized fruit cultivars.

Data on the average fruit weight and stone weight for the period 2014-2015 are presented in Table 2. Fruits of 'Balvanska slava' cultivar have high values of fruit weight – 37.24 g. The fruits of 'Althan's Gage' and 'Čačanska leptotica' are after them – respectively with a weight of 36.51 g and 36.38 g. These cultivars according to our opinion come into the group of large-sized cultivars. In the second cultivar group as regard to fruit weight come 'Ontario', 'Stanley', 'Strinava', 'Gulyaeva', 'Hramova renkloda', 'Gabrovska'. 'Opal' appeared to have the smallest fruit in size, compared to the other 9 cultivars. The differences were statistically proven – LSD = 2.18 at  $\alpha = 0.05$ .

Data show that stone weight (Table 2) is the greatest for 'Ontario' – 1.78 g. It is followed by 'Balvanska slava', 'Čačanska leptotica' and 'Stanley'. 'Opal' is distinguished

with the lowest values of that indicator – 0.57 g, which can be explained by the fact that the fruits of that cultivar have the smallest weight. For this indicator LSD = 0.16.

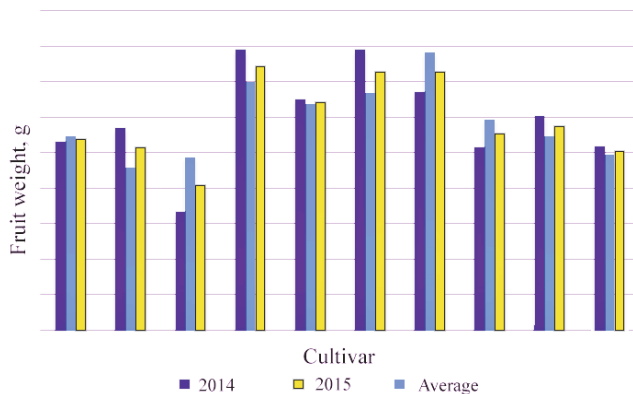
Very interesting data are obtained for the percentage ratio of the stone compared to the fruit weight. 'Stanley' fruits are distinguished with the highest percentage (4.91%), followed by 'Gabrovska' – 4.34%. It was found out that the fruit stone in 'Opal' cultivar has the smallest percentage of the fruit weight – 2.82%.

Dry matter is an important indicator of plum quality. According to Freyman et al. (1969) fresh plums have dry matter from 9,6% to 31%, depending on the variety and growing conditions. With regard to the dry matter, it was found that for the period 2014-2015 the fruits of Gulyaeva have the highest dry matter – 21.94%, followed by 'Strinava' – 21.40% and 'Čačanska leptotica' – 20.06%. The fruits of 'Ontario' have the lowest dry matter – 16.83% (Table 2).

The average fruit weight is different for cultivars under observation during the years of the experiment. Data are presented for the different years in Figure 1. There are almost no major differences in the fruit weight for 'Hramova renkloda' and 'Ontario' cultivars. In 2014, the following cultivars have a greater fruit weight in comparison with 2015: 'Stanley', 'Balvanska slava', 'Althan's Gage' and 'Strinava'. The following cultivars have a greater fruit weight in the second experimental year – 2015 in comparison with 2014: 'Opal', 'Čačanska leptotica' and 'Gulyaeva'. The differences in the average fruit weight can presumably be due to the different reaction of cultivars to the conditions in the growing region. We should not forget the fact that the experiment is conducted under non-irrigated conditions, which is a prerequisite for stress in plants.

**Table 2**  
**Fruit weight and stone weight, dry matter content in fresh fruits, average for the period 2014-2015**

Cultivar	Fruit weight, g	Stone weight, g	Percentage of fruit stone in relation to fruit weight – %	Dry matter, %
Stanley	25.74	1.24	4.91	19.14
Strinava	28.78	1.10	3.84	21.40
Gabrovska	25.35	1.07	4.34	18.56
Gulyaeva	27.76	1.04	3.76	21.94
Balvanska slava	37.24	1.36	3.65	19.70
Hramova renkloda	27.00	1.07	3.98	16.92
Opal	20.54	0.57	2.82	17.19
Ontario	32.20	1.78	3.02	16.83
Althan's Gage'	36.51	1.20	3.36	17.63
Čačanska leptotica	36.38	1.24	3.45	20.06
$\alpha = 0,05$	LSD= 2.18	LSD= 0.16	LSD= 0.38	LSD= 0.77



**Fig. 1. Average value of fruit weight for different years in the period 2014-2015**

## Conclusions

Cultivars can be divided in the following groups, considering the biometric measurements that have been made under the conditions in the Experimental Station in the town of Dryanovo and the data on the fruit sizes, average weight, the surface (S), arithmetic diameter (Da), and geometric diameter (Dg):

- Cultivars with large-sized fruits: ‘Balvanska slava’, ‘Čačanska lepotica’ and ‘Althan’s Gage’.
- Cultivars with average-sized fruits: ‘Stanley’, ‘Ontario’, ‘Gabrovska’, ‘Strinava’, ‘Hramova renkloda’ and ‘Gulyaeva’.
- Cultivars with small-sized fruits: ‘Opal’.

In comparison with the other 9 cultivars, fruits of ‘Balvanska slava’ have both the largest weight – 37.24 g and surface – 52.87 cm<sup>2</sup>.

Under the conditions of the town of Dryanovo, the fresh fruits of the following cultivars are distinguished with high dry matter content over 20%: ‘Gulyaeva’, ‘Strinava’ and ‘Čačanska lepotica’.

In our opinion, Bulgarian cultivars such as ‘Gabrovska’, ‘Strinava’, ‘Gulyaeva’ and ‘Balvanska slava’ deserve a greater distribution in the new plantings in order to diversify the assortment of plums in Central Bulgaria.

## References

- Dinkova, Hr. and K. Dragoyski, 2005. New introduced plum cultivars and possibilities for their growing in Bulgaria. *Plant Science*, 42: 34-37.
- Dragoyski, K., Hr. Dinkova, B. Stefanova and P. Mihailova, 2009. Evaluation of plum cultivars suitable for sustainable fruit production in the mountain regions of Bulgaria, Vocarstvo. *Journal of Pomology*, 43, 165-166, 37-43.
- Dzhuvinov, V., 2000. Current problems of Bulgarian fruit growing, Agricultural Science. *Bulgarian Journal of agricultural Science*, 6: 7-9.
- Freyman, I.A., V.V. Arasimovich; V.V. Bezpechalnaja, L.L. Borshtanskaja, N.A. Solovieva and N.P. Ponomareva, 1969. Biochemistry of Stone Fruit in Moldova, pp. 15-28.
- Iliev, P. and A. Stoev, 2010. Perspective cultivars for the plum production in Bulgaria, Veliko Tarnovo, collection “Bulgaria and Bulgarians in Europe”, pp. 556-564.
- Ministry of Agriculture and food Republic of Bulgaria, 2007. Quality Control of Fresh Fruit and Vegetables, pp. 226-231.
- Ministry of Agriculture and food Republic of Bulgaria, 2011. Agricultural statistic. Bulletin № 176. [www.mzh.government.bg](http://www.mzh.government.bg)
- Ministry of Agriculture and food Republic of Bulgaria, 2015a. Agricultural statistic, Bulletin № 281 [www.mzh.government.bg](http://www.mzh.government.bg)
- Ministry of Agriculture and food Republic of Bulgaria, 2015b. Agricultural statistic, Bulletin № 289 [www.mzh.government.bg](http://www.mzh.government.bg)
- Nedev, N., I. Grigorov, H. Baev, S. Serafimov, A. Strandjev, L. Kavardzиков, K. Lazarov, N. Nikolov, V. Djuvinov, L. Popova, N. Slavov, P. Iliev, D. Stoyanov, I. Kanev, H. Krinkov, U. Vishanska and M. Topchiyska, 1979, Methodology for Studying Plant Resources, Plovdiv.
- Vitanova, I., S. Dimkova and D. Ivanova, 2002. Perspective Bulgarian Plum Cultivars, Materials of the International Conference “Problems in Vegetables and Fruit Growing Development”, Ijevsk, pp. 75-77.
- Vitanova, I., S. Dimkova, D. Ivanova, N. Marinova and S. Todorova, 2011. Plum Cultivar “Strinava”. *Plant Science*, 48: 58-61.
- Vitanova, I., D. Ivanova and S. Dimkova, 2005. Biological characteristic of plum cultivars, created in the Experimental station – Dryanovo. *Journal of Mountain Agriculture on the Balkans*, 8 (5): 708-717.
- Vitanova, I., N. Marinova, D. Ivanova, S. Dimkova and H. Kutinkova, 2010. Plum Production in Bulgaria. *Acta Horticulturae*, 874: 373-375.