Fruit Growing Research, Vol. XXXVII, 2021 DOI 10.33045/fgr.v37.2021.07
https://publications.icdp.ro/index.php

CALITATEA FRUCTELOR LA UNELE SOIURI DE PRUN NOU INTRODUSE IN BULGARIA

FRUIT QUALITY OF NEW INTRODUCED PLUM CULTIVARS UNDER THE CONDITIONS OF BULGARIA

Nesheva Marieta[1*], Butac Madalina[2]
[1]Fruit Growing Institute Plovdiv, Bulgaria
[2]Research Institute for Fruit Growing Pitesti, Romania
*Corresponding author: Nesheva Marieta; e-mail marieta.nesheva@abv.bg

Abstract

***Prunus domestica* L. is one of the most commonly grown fruit species in Bulgaria due to its high ecological adaptation and multiple ways of fruit marketing. Fruit quality is associated with attributes such as appearance, texture, taste and colour. Breeding and new cvs. introduction are in constant search for cultivars with better fruit quality that would answer the increasing consumer requirements. In 2013 the Romanian plum cvs. 'Pitestean', 'Roman', 'Romanta', 'Carpatin' and 'Tita' were introduced in Bulgaria and planted in a collection orchard at the Fruit Growing Institute, Plovdiv. The study was conducted in the period 2016-2021. It aimed to evaluate the fruit quality when the cultivars are grown under the agro-environmental conditions of the region. For obtaining this objective, fruit weight, fruit flesh firmness, TSS (°Brix), skin colour with and without wax bloom and fruit flesh colour were measured. For evaluating consumer acceptance, a sensory analysis was performed. 'Roman' had the largest fruits with an average fruit weight of 46.66 g and the highest TSS content – 18.2°Brix. There were significant differences in the colour parameters L*, a*, b*, Chroma and Hue between the cultivars and the wax bloom had a significant effect on colour parameters. All fruits were appreciated by the testing panel of consumers and their taste qualities were evaluated as good and very good.**

Cuvinte cheie: evaluare, calitatea fructelor, *Prunus domestica* L., soiuri de prun, TSS
Key words: evaluation, fruit quality, *Prunus domestica* L., plum cultivars, TSS

1. Introduction

Plum (*Prunus domestica* L.) is a traditional fruit species in Bulgaria. It ranks third after walnut and sweet cherry with 12,098 ha of plum orchards and first in the amount of fruit production. In 2020 an increase of 6.9% was observed in the planted areas (Agrostatistics, 2020). That shows a good demand for this fruit species among the producers. 'Stanley' cv. is the most widespread cv. in the plum orchards. In 2017 the cv. occupied 73.4% of the orchards, followed by 'Čačanska lepotiča' with 5.8% and 'Jojo' with 4% (Agrostatistics, 2019). The prevailing single cv. is a fact that could be changed as a result of the studies on new plum genetic resources, by introducing and establishing new cv. that comply with the latest issues of producers and consumers (Bozhkova, 2013).

Plum is also one of the major fruit species grown in Romania and the country is developing extensive *Prunus domestica* L. breeding programs. The Romanian plum breeding has been started in 1950 and as a result, a total number of 40 cultivars were registered (Butac et al, 2013; Butac 2020). The introduction of new cultivars could improve the plum orchards structure in the country and influence directly fruits production. Studies of new plum genetic resources also influence directly the breeding process for the selection of donors in the breeding schemes (Bozhkova and Zhivondov, 2004; Blazek, 2007).

The good quality of the fruits is one of the most important and highlighted breeding objectives and one of the main elements that induce the acceptance of the cultivars by growers (Bassi and Audergon, 2006). It is also fundamental for the acceptance of cultivars by consumers whose requirements are constantly increasing (Egea et al., 2010, Harker et al, 2008). Fruit quality is associated with attributes such as appearance, texture, taste and colour. Most of the parameters determining the quality of the fruit are influenced by the environmental conditions in the year of cultivation (Dirlewanger et al., 1999).

Due to the interaction between environment and genotype, it is very important to evaluate preliminarily the agronomical and pomological performance of all newly introduced or released cvs. in the areas in which they will be cultivated (Liverani et al, 2010).

In 2013, the Romanian cultivars 'Pitestean', 'Roman', 'Romanta', 'Carpatin' and 'Tita' were introduced in Bulgaria and planted in a collection orchard at the Fruit Growing Institute. This study aimed

to describe the fruit quality that these cultivars provide when they are grown in the agro-environmental conditions of Plovdiv, Bulgaria.

2. Material and methods

The study was conducted in the period 2016- 2021 in a collection orchard at the Fruit Growing Institute Plovdiv, Bulgaria. The 'Pitestean', 'Roman', 'Romanta', 'Carpatin' and 'Tita' cvs. were planted in 2013. The orchard was grown on humus carbonate soil, maintained as black fallow**,** under non-irrigation conditions, at a planting distance of 4 x 4 m, applying conventional plant protection practices. 'Stanley' cv. was used as standard.

The fruit quality evaluation included biometrical, colorimetric and sensory analyses. An average sample of 25 fruits was taken and average fruit weight was measured with digital scale. Plum fruits were subjected to colour evaluation in the CIE L*a*b* system using handheld colorimeter PCE-CSM 2, measuring the equatorial part of 10 fruits with a natural wax bloom, with removed bloom and their fruit flesh colour. The 0 L* values represent the black colour, 100-represents a perfect reflecting diffuser (bright). A positive a* value indicates red and a negative a* value green colour, a positive b* value indicates yellow and a negative b* value blue colour. The Hue angle expresses the colour nuance and values are defined as follows: red-purple: 0°, yellow: 90°, bluish-green: 180°, and blue: 270° (McGuire, 1992; Voss, 1992). The Chroma, defines the saturation of the colour. Fruit firmness was measured using a PCE-PTR-200N digital penetrometer. The total soluble solids content was measured using digital refractometer Kern ORF 85BM.

For sensory evaluation of the fresh fruits a methodology developed at the Fruit Growing Institute Plovdiv was used. A total number of 8 characteristics were scored by a group of trained consumers using the following scale: 1-3 - bad; 3-5-satisfactory; 5-7 good, 7-8 – very good, above 8 - excellent. Each characteristic was multiplied by a coefficient, established by the scientists of section "Breeding, genetic resources and biotechnology" at the Fruit Growing Institute Plovdiv, depending on its importance: 0.175 for appearance, 0.050 for aroma attractiveness and 0.225 for aroma intensity, 0.200 for sweetness, 0.125 for sour taste, -0.125 for bitterness, 0.200 for taste balance, and 0.150 for fruit flesh texture and juiciness (Neshev et al., 2021).

3. Results and discussions

3.1 Fruit ripening time and biometrical characteristics

The official fruit quality standard for fruits intended for fresh consumption relies on the fruit size (Polat and Caliskan, 2013). Its main indicator is the fruit weight. The fruits of all introduced cultivars ripen before 'Stanley' which is a valuable feature for the fruit producers (Table 1). Statistically, the largest fruits were obtained from the trees of 'Roman' cv. and the smallest from 'Romanta' cv. According to the fruit size standards for *Prunus domestica* L., the fruits of 'Roman' and 'Tita' cvs. could be classified as large-sized. The fruits obtained from 'Pitestean', 'Romanta', 'Carpatin' cvs. and the standard 'Stanley' cv. could be classified as medium-sized (Blažek et al, 2004). 'Carpatin' and 'Tita' cvs. had the smallest stones and the best stone relative share (%) with a statistically significant difference compared to the standard and the other studied cultivars.

3.2 Fruit firmness and total soluble solids content

Fruit flesh firmness is relevant to an assessment of the quality of fruit, affecting fruit shelf life, and to consumer acceptance. Fruit flesh firmness is a combination of skin and flesh strength, and in general, genotypes with the firmest fruit are preferred (Hend et al., 2009). All studied cultivars had fruit firmness above 3 kg/0.5 cm^2 (Fig. 1). The introduced Romanian cv. 'Roman' had the firmest fruits followed by the standard 'Stanley'. These two cultivars had the highest TSS content, too (Fig. 2). The TSS content is important for the production of dried fruits. Its high content is associated with a higher amount of sugars and increases the yield and quality of the dried product.

3.3 Fruit colour

Characteristics such as colour, size, shape and external defects of the fruits predominantly determine the choice made by the customers on the market (Azodanlou et al., 2003). Fruit colour is one of the elements that make the strongest impact through the quality components (Tourjee et al., 1998). There were significant differences in the colour parameters L*, a*, b*, Chroma and Hue between the six cvs. The chromatic characteristics of the fruits and fruit flesh are shown in Tables 2, 3 and 4. The hue angle values of the cvs. 'Tita', 'Romanta', 'Carpatin' and 'Stanley' corresponded to the violet-blue colour. The measured for 'Pitestean' hue angle corresponded to its dark blue colour and for 'Roman' – dark violet. All cultivars skin colour is a combination between blue (- b*) and red (+a*) pigment. According to the a* and b* values statistically, significant differences between all cultivars were found for the measured quantity of red pigment (+ a* value). The skin colour of 'Roman' had the highest values. 'Roman' also had the brightest colour before and after removing the wax bloom with the highest measured Chroma. The

waxy coating has a significant effect on colour parameters (Walkowiak-Tomczak et al., 2008). There is a difference between the a* and b* coordinates before and after removing the wax coating. The average L* value significantly decreases after polishing the fruits. The colour of the fruit flesh of all cultivars is a combination between the red (+a*) and yellow (+b*) pigment and corresponds to the yellowish-green and yellow colour. 'Tita' had the darkest colour of the fruit flesh. A brighter colour with a higher measured Chroma had 'Stanley' and 'Romanta'.

3.4 Fruit sensory evaluation

The fruit quality is a combination of their physical and chemical characteristics – appearance, consistency, taste and aroma (Velisek and Cejpek, 2007). Fruit appearance is the quality attribute which determines their commercial value. The testing panel of trained consumers evaluated with the highest scores the fruits of 'Romanta' (Table 5). Usually, well-informed consumers prefer fruits with good taste and when they are valued by sensory analyzes, taste and aroma are of greater importance (Bozhkova and Nesheva, 2016). The sweet taste of 'Tita', 'Roman' and 'Stanley' was highly appreciated by the testing panel of consumers. The fruits of the standard cultivar had the most balanced taste followed by 'Carpatin'. According to the consumers in the testing panel, 'Stanley' had the best fruit flesh texture, followed by 'Romanta'. After the sensory analyses, the fruits obtained of the standard cultivar and 'Carpatin' were evaluated as very good. With very little difference compared to them were the fruits of 'Tita', its fruits were evaluated as good.

4. Conclusions

In the agro-climatic condition of Plovdiv, Bulgaria the introduced Romanian cultivars showed qualitative large and medium-sized fruits. They are firm with high TSS content. The fruits of 'Pitestean' had the most intensive dark blue skin colouration. All studied cultivars had yellowish-green to yellow fruit flesh. The taste quality of all fruits is highly evaluated by the consumers. 'Tita', 'Pitestean' and 'Romanta' show excellent productivity in the environmental conditions of the region and taking into account their fruit quality are considered as recommended for introduction in the Bulgarian plum production orchards.

References

1. Agrostatistics Handbook. 2019. Study of the structure of fruit species in 2017. Ministry of Agriculture, Food and Forestry. Sofia.
2. Agrostatistics Handbook. 2020. Ministry of Agriculture, Food and Forestry. Sofia.
3. Azodanlou R., Darbellay C., Luisier J. L., Villettaz J. C., Amadò R., 2003. Development of a model for quality assessment of tomatoes and apricots. LWT- Food Science and Technology, 36(2): 223-233.
4. Bassi D., Audergon J.M., 2006. Apricot breeding: update and perspectives. Acta Hort. 701: 279-294.
5. Blazek J., 2007. A survey of the genetic resources used in plum breeding. Acta Hort. 734: 31-45.
6. Blažek J., Vávra R., Pištěková I., 2004. Orchard performance of new plum cultivars on two rootstocks in a trial at Holovousy in 1998–2003. Horticultural Science, 31(2): 37-43.
7. Bozhkova V., 2013. Plum genetic resources and breeding. AgroLife Scientific Journal, 2(1): 83-88.
8. Bozhkova V., Zhivondov A., 2004. Cultivars commonly used as donors at the breeding for improvement of plum varietal assortment. Pant sciences, 41: 51-54.
9. Bozhkova V., Nesheva M., 2016. Some results of evaluation of new-introduced apricot cultivars under conditions of Plovdiv region. Agricultural science and technology, 8(3): 262-265.
10. Butac M., Bozhkova V., Zhivondov A., Milosevic N., Bellini E., Nencetti V., Blazek J., Balsemin E., Lafarque B., Kaufmane E., Gravite I., Vasiljeva M., Pintea M., Juraveli A., Webster T., Hjalmarsson I., Trajkovski V., Hjeltnes S.H., 2013. Overview of plum breeding in Europe. Acta Hortic. 981: 91-98.
11. Butac M., 2020. Plum breeding. In: *Prunus*. Intech Open, London, United Kingdom (Open Access books).
12. Dirlewanger E., Moing A., Rothan C., Svanella L., Pronier V., Guye A., Plomion C., Monetet R., 1999. Mapping QTLs controlling fruit quality in peach (*Prunus persica* (L.) Batsch). Theoretical and Applied Genetics 98.1: 18-31.
13. Egea J., Dicenta F., Burgos L., Martinez-Gomez P., Rubio M., Campoy J. A., Ortega E., Patiño J.L., Nortes L., Molina A., Ruiz D., 2010. New apricot cultivars from CEBAS-CSIC (Murcia, Spain) breeding programme. Acta Hort. 862: 113-118.
14. Harker FR., Kupferman EM., Marian AB., Gunson FA., Triggs CM., 2008. Eating quality standards for apples based on consumer preferences. Postharvest Biology and Technology. 50(1): 70-78.
15. Hend B., Ghada B.M., Sana M., Mohamed T., Mokhtar S.H., 2009. Amel Genetic relatedness among Tunisian plum cultivars by random amplified polymorphic DNA analysis and evaluation of phenotypic characters Sci. Hortic., 121: 440-446.

16. Liverani A., Giovannini D., Versari N., Sirri S., Brandi F., 2010. Japanese and European plum cultivar evaluation in the Po valley of Italy: Yield and climate influence. Acta Hortic. 874: 327-336.
17. McGuire R. G., 1992. Reporting of objective color measurements. HortScience, 27(12): 1254-1255.
18. Neshev N., Nesheva M. Akova V., 2021. Agronomic and fruit quality characteristics of the Bulgarian plum cultivar 'Pagane'. Acta Hortic. 1322: 33-40.
19. Polat A.A., Caliskan O., 2013. Yield and fruit characteristics of various apricot cultivars under subtropical climate conditions of the Mediterranean Region in Turkey. International Journal of Agronomy.
20. Tourjee K.R., Barrett D.M., Romero M.V., Gradziel T.M., 1998. Measuring flesh color variability among processing clingstone peaches genotypes differing in carotenoid composition. J. Am. Soc. Hortic. Sci. 123 (3): 433–437.
21. Velisek J., Cejpek K., 2007. Biosynthesis of food constituents: vitamins. 1. Fat-soluble vitamins – a review. Czech J. Food Sci. 25 (1): 1–16.
22. Voss D. H., 1992. Relating colorimeter measurement of plant color to the Royal Horticultural Society Colour Chart. HortScience, 27(12): 1256-1260.
23. Walkowiak-Tomczak D., Reguła J., Łysiak G., 2008. Physico-chemical properties and antioxidant activity of selected plum cultivars fruit. Acta Sci. Pol. Technol. Aliment. 7 (4): 15–22.

Tables and Figures

Table 1. Average harvest date and fruit size parameters on 2016-2021 periods

Cultivar	Ripening time (average date)	Average fruit weight (g)	Average stone weight (g)	Stone relative share (%)
Pitestean	July 24	38.11 ab*	1.66 b	4.45 a
Roman	August 3	46.66 a	2.17 a	4.68 a
Romanta	August 31	35.66 b	1.57 b	4.49 a
Tita	July 30	44.22 ab	1.21 c	2.79 b
Carpatin	July 30	37.79 ab	1.06 c	2.93 b
Stanley	September 4	38.79 ab	1.88 ab	4.94 a

*Mean values followed by a different letter show a statistically significant difference by Duncan's multiple range test (P<0.05)

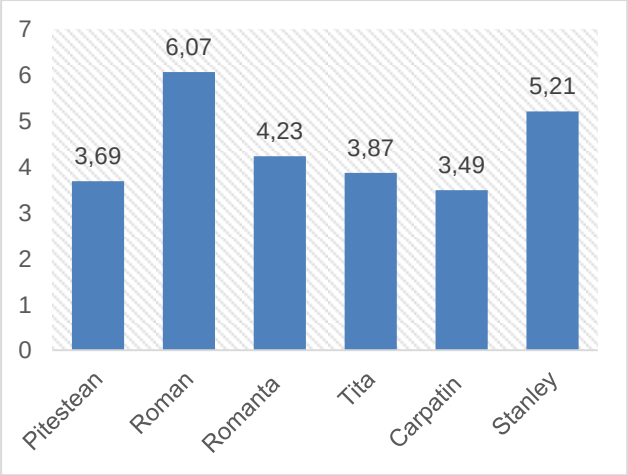

Fig. 1. Fresh fruit firmness (kg/0.5cm^2)

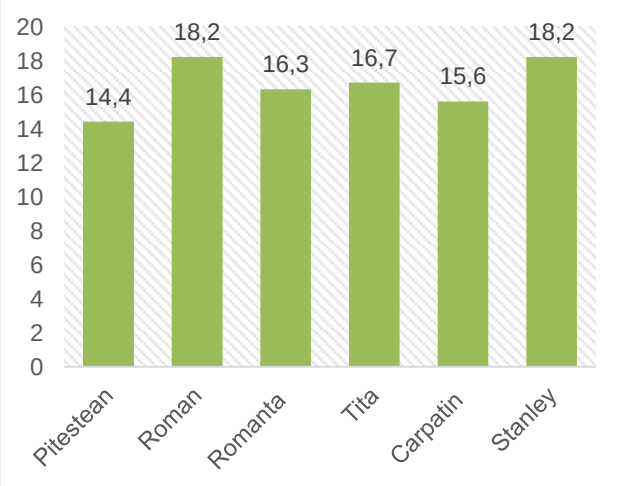

Fig. 2. Total soluble solids content (^{0}Brix)

Table 2. Skin colour of the fruits with wax bloom

Cultivar	Colour parameters				
	L*	a*	b*	Chroma	Hue
Pitestean	40.23 a	-0.06 b	-8.43 a	8.48 ab	270.74 b
Roman	33.32 a	6.20 a	-6.19 a	9.63 a	312.52 a
Romanta	29.57 a	2.25 ab	-4.72 a	5.68 b	301.28 ab
Tita	34.83 a	2.53 ab	-5.82 a	7.65 ab	301.88 ab
Carpatin	39.92 a	2.65 ab	-5.64 a	7.91 ab	300.76 ab
Stanley	36.81 a	2.98 ab	-8.76 a	9.51 a	290.47 ab

*Mean values followed by a different letter show a statistically significant difference by Duncan's multiple range test (P<0.05)

Table 3. Skin colour of the fruits with wax bloom removed

Cultivar	Colour parameters				
	L*	a*	b*	Chroma	Hue
Pitestean	20.37 a	5.41 b	-0.63 b	5.61 b	5.55 b
Roman	23.18 a	13.66 a	4.14 ab	14.42 a	14.04 ab
Romanta	20.66 a	6.37 b	0.95 ab	6.45 b	8.33 ab
Tita	21.06 a	7.09 b	0.56 ab	7.16 b	7.34 ab
Carpatin	25.33 a	7.61 b	7.89 a	14.10 a	28.93 a
Stanley	22.28 a	9.93 ab	1.09 ab	10.15 ab	14.05 ab

*Mean values followed by a different letter show a statistically significant difference by Duncan's multiple range test (P<0.05)

Table 4. Colour of the fruit flesh

Cultivar	Colour parameters				
	L*	a*	b*	Chroma	Hue
Pitestean	51.30 a	1.08 b	19.81 c	19.85 c	86.94 a
Roman	43.88 ab	6.49 a	27.09 bc	27.88 bc	76.63 a
Romanta	50.69 a	7.65 a	38.15 ab	38.92 a	78.63 a
Tita	41.21 b	6.61 a	26.99 bc	27.80 bc	76.02 a
Carpatin	44.08 ab	2.04 b	25.31 c	29.47 b	89.35 a
Stanley	49.82 a	4.46 ab	39.44 a	39.72 a	83.76 a

*Mean values followed by a different letter show a statistically significant difference by Duncan's multiple range test (P<0.05)

Table 5. Fruit sensory analyses scores, average for the period 2019-2021

Cultivar	Appearance	Aroma		Taste				Flesh texture and juiciness	Final evaluation	
		Attractive	Intensive	Sweet	Sour	Bitter	Balance			
Pitestean	1.40	0.28	0.78	0.89	1.71	-0.16	1.06	1.17	6.10	Good
Roman	1.43	0.34	0.92	1.26	0.56	-0.13	1.17	1.19	6.74	Good
Romanta	1.51	0.36	0.86	1.13	0.42	-0.18	1.15	1.24	6.47	Good
Tita	1.41	0.35	1.07	1.33	0.48	-0.12	1.22	1.17	6.92	Good
Carpatin	1.25	0.43	0.97	1.28	0.46	-0.1	1.33	1.4	7.02	Very good
Stanley	1.43	0.41	1.25	1.32	0.38	-0.43	1.39	1.28	7.02	Very good