Fruit growing research, vol. XXVIII, 2012

CRITERII PENTRU APRECIEREA MATURITĂŢII OPTIME DE RECOLTARE A PRUNELOR DESTINATE PIEŢEI DE FRUCTE PROASPETE LA UNELE SOIURI ROMANESTI

CRITERIA FOR HARVESTING PLUMS AT THE OPTIMUM MATURITY FOR ROMANIAN VARIETIES OF THE FRESH FRUIT MARKET

Madalina Butac, Madalina Militaru, Sergiu Budan
Research Institute for Fruit Growing Pitesti, Romania

Abstract

Plum breeders and growers from Romania want to improve status of the plums for fresh consumption. Plum fruit quality depends on physical and chemical properties (shape, size, skin colour, bloom, taste and flavor, fruit soluble solids content and acidity, stone adherence), but, also, the optimum time to harvesting for the fresh fruit market. Optimum fruit maturity of plum varieties can be achieved by the fruit colour and firmness. For this reason we have studied seven new Romanian plum varieties ('Alina', 'Carpatin', 'Roman', 'Pitestean', 'Sarmatic', 'Tita' and 'Tuleu timpuriu'), cultivated in field trial of the Genetics and Breeding laboratory in Research Institute for Fruit Growing Pitesti. Fruit skin color was measured by Konica Minolta chromameter model CR 400 based on the Hunter L, a, b-system. Fruit firmness was measured with non-destructive penetrometer Qualitest HPE equipped with a plunger of diameter 0.10 cm^2. In addition to these two criteria were also measured others, such as: fruit size, fruit color and fruit soluble solids content. For statistical analyses DUNCAN test was used. Fruit colour ranged from red (Roman) to dark blue (Pitești an). According to the colour chart CTIFL, plum varieties were classified as group 4 - light blue ('Alina', 'Carpatin', 'Roman', 'Tuleu timpuriu') 5 - blue ('Sarmatic' and 'Tita') and 6 - dark blue ('Pitești an'). After firmness, varieties were grouped into two groups: group 2 - beginning of maturation ('Carpatin', 'Roman', 'Sarmatic', 'Tita', 'Tuleu timpuriu') and group 3 - optimal harvest time ('Alina' and 'Pitești an'). Regarding the other criteria, like fruit weight and soluble solids content, it can be said that all studied varieties are suitable for fresh consumption.

Keywords: *Prunus domestica*, fruit quality, colour, firmness
Cuvinte cheie: *Prunus domestica,* calitate fruct, culoare, fermitate

1. Introduction

In the national strategy of research - development for the period 2007 - 2013, sustainable agriculture must responds to the requirements which demand healthy food and quality consistent with general and specific market needs (Braniste et al., 2008).

In this context, an important objective is improving the fruit quality of varieties for fresh consumption and processed. Plum breeders and growers from Romania want to improve fruit quality for fresh consumption. Plum fruit quality depends on physical and chemical properties (shape, size, skin colour, bloom, taste and flavor, fruit soluble solids content and acidity, stone adherence), but, also, the optimum time to harvesting for the fresh fruit market (Cociu et all., 1997; Butac et Bulgaru, 2001; Butac et al., 2009).

The aim of this paper is to establish the optimal time to fruit harvest from some Romanian plum varieties for fresh consumption by considering fruit colour and firmness, but also other characters and features such as size, color fruit appreciated visual and soluble solids content.

Fruit color and firmness are important quality factor in stone fruits, often related to taste and shelf life. Evaluation of these two indicators is widely used both in the marketing chain to assess fruit quality, but also by researchers in testing different genotypes for registration (Seks et all., 2008; Vangdal and Flatland, 2008).

2. Material and Methods

For this reason we have studied seven new Romanian plum varieties ('Alina', 'Carpatin', 'Roman', 'Pitestean', 'Sarmatic', 'Tita' and 'Tuleu timpuriu'), cultivated in the field trial of the Genetics and Breeding laboratory in Research Institute for Fruit Growing Pitesti. At these varieties were determined:

- fruit colour appreciated visual and also with the colour chart developed by CTIFL for sweet cherries (Planton, 1995) (fig. 1);

- the external skin colour parametters (*L, a, b*) were measured using a Konica Minolta CR 400 chromameter, where *L* corresponds to Luminance, and *a* and *b* to the chromaticity coordinates (on green to red and blue to yellow tones, respectively. (fig. 2);

- fruit firmness was measured with non-destructive penetrometer Qualitest HPE equipped with a plunger of diameter 0.10 cm^2 (fig. 3);
- fruit weight was recorded with a balance in g/fruit;
- soluble solid contents were measyred with a portable refractometer, in % Brix (fig. 4).

Data were analysed statistically using Duncan's multiple range test - $P \leq 0.05$ (Botu et Botu, 1997).

3. Results

Fruit colour

To appreciate the fruit colour of plum varieties studied we are using several methods: visual appreciation, colour chart developed for cherry from CTIFL France and Konica Minolta chromameter. Thus, fruit colour ranged from red ('Roman') to dark blue ('Pitestean'). According to the color chart CTIFL, plum varieties studied were classified in group 4 – light blue ('Alina', 'Carpatin', 'Roman', 'Tuleu timpuriu') 5 – blue ('Sarmatic' and 'Tita') and 6 – dark blue ('Pitești tean') (Table 1).

The CIELAB colour scale is an approximately uniform color scale. In a uniform color scale, the differences between points plotted in the color space correspond to visual differences between the colours plotted. The CIELAB colour scale is organized in a cube form. The l* axis runs from top to bottom. The maximum for L* is 100, which represents a perfect reflecting diffuser. The minimum for L* is zero, which represents black. The a* and b* axes have no specific numerical limits. Positive a* is red. Negative a* is gree. Positive b* is yellow. Negative b* is blue.

Analyzing the data from Table 1, it is noted that, there are not significant differences between varieties. Average value for L* is 25.99, values ranging between 22.22 ('Roman') and 29.26 ('Alina'), values which situated varieties on L* axis closer to black colour.

Regarding axis a*, values obtained show that there are significant differences between varieties. Thus, the average was 5.58, which is red colour, the highest values occurring at 'Alina' variety, 8.21 (light blue fruit) and lowest at 'Pitestean' variety, 2.35 (dark blue fruit) (Table 1, Fig. 5).

On axis b * is found also that there are significant differences between varieties, most values are negative, indicating blue colour. The average value was -1.06, the highest values (positive) were 'Roman' (1.2) and 'Alina' (0.61) varieties, which have red and blue fruit, and the lowest values (negative) occurring at 'Tita' (-2.94) and 'Pitestean' (-4.99) varieties, which have blue and dark blue fruits (Table 1, Fig. 5).

It is known that, when approaching of optimum maturity varieties become more lightness (L *), more red (a *) and more blue (b *) (Vangdal et Flatland, 2008). Given these results and the fact that all varieties were harvested on July 24 can be said 'Pitestean' and 'Alina' varieties were close to the optimum maturity stage and other varieties to the beginning of maturity.

Even though colour charts may be of some help, the best criterion for judging maturity stage of fruit was firmness and soluble solids content.

Firmness measurements

To assess the fruit firmness, plum varieties were harvested on 24 July. Statistical analysis of the data using Duncan's multiple range test ($P \leq 0.05$) allowed grouping varieties studied in a single variation class among varieties were no significantly different. Average fruit firmness was 69.28 units HPE (N/0.10 cm^2), the maximum amplitude variation being 24.60 units HPE, the lowest average recorded at variety 'Pitestean' (62.70 units HPE) and the highest average was recorded at 'Tuleu timpuriu' variety (72.23 units HPE). The standard deviation was 7.82 units HPE and coefficient of variation (standard deviation / mean, expressed as a percentage) was small, 11.23%. Asymmetry coefficient has a low value, positive (0.303), indicating a predominance of higher values of average fruit firmness and vaulting or excess coefficient had a negative value of -0.962, suggesting the occurrence of excess numbers near average and far from it, with a drain flanks distribution (Table 2, Fig. 6).

Given the classification made by E. Vangdal in maturation groups according to the fruit firmness (Table 3), Romanian plum varieties were grouped into two groups: group 2 (firmness 70-79) - beginning of ripening (fruits should not be picked, if however, picked, it should be allowed to ripen before marketing) and group 3 (firmness 60-69) - optimal harvest time (fruit is optimal stage of harvest and marketing), which means that cultivars 'Carpatin', 'Roman', 'Sarmatic', 'Tita' and 'Tuleu timpuriu' would have been left a few days and then harvested (Table 2).

Fruit weight

An important role in marketing for plum varieties designated for fresh consumption has fruit size.

Statistical analysis of data on fruit weight, using Duncan's multiple range test ($P \leq 0.05$) allowed grouping varieties studied in 4 homogeneous groups of weight between varieties were significant differences. Average weight of fruit on the 7 plum varieties studied had a value of 44.19 g, maximum amplitude of variation is 25 g, the highest average weight recorded in 'Roman' variety (53.67) and the lower average values variety 'Tuleu timpuriu' (32.33 g). The standard deviation was 7.54 g, and the coefficient of variation (standard deviation / mean, expressed as a percentage) was small, only 17.06%. Asymmetry coefficient has a low value, negative (-0.564), indicating a predominance of higher values of average fruit weight and vaulting or excess coefficient had a negative value of -0.935, suggesting the

occurrence of excess numbers near the middle and away from her with a drain flanks distribution (Fig. 7, 8).

After European descriptors Prunus Data Base (EPBD) used to describe varieties in *Prunus* genus, it appears that most varieties studied were placed in Group 7 - Fruit large (41-55 g) and they are recommended for fresh consumption.

Fruit soluble solids content

Fruit soluble solids content is very important to prune, as well as to other fruits, it mostly depends on the taste of fruit. After statistical processing of data, plum varieties were classified into one homogenous group, the values were not statistically assured. Thus, the average soluble dry substance was 17.32%, the amplitude being 6.90, the highest soluble solids content in fruit variety is 'Sarmatic' (18.57%) and lowest in variety 'Roman' (16.23%). It should be noted that all varieties had more than 16% soluble solids, designed for fresh consumption (Fig. 5 and 6). As with other characteristics analyzed, the standard deviation was low, of 1.46%, the coefficient of variation was 8.43% (very small variation), almost all values of 21 determinations being over 16% dry soluble (Fig. 9, 10).

4. Conclusions

Fruit colour ranged from red ('Roman') to dark blue ('Pitestean'). According to the color chart CTIFL, plum varieties studied were classified in group 4 – light blue ('Alina', 'Carpatin', 'Roman', 'Tuleu timpuriu') 5 – blue ('Sarmatic' and 'Tita') and 6 – dark blue ('Pitești'). Average value for L* is 25.99, values which situated varieties on L* axis closer to black colour, the average value for a* was 5.58, which is red colour and for b * was -1.06, which is blue.

It is known that, when approaching of optimum maturity varieties become more lightness (L *), more red (a *) and more blue (b *). Given these results and the fact that all varieties were harvested on July 24 can be said 'Pitestean' and 'Alina' varieties were close to the optimum maturity stage and other varieties to the beginning of maturity.

Even though colour charts may be of some help, the best criteria for judging maturity stage of fruit was firmness and soluble solids content.

Given the classification made by E. Vangdal in maturation groups according to the fruit firmness, Romanian plum varieties were grouped into two groups: group 2 (firmness 70-79) - beginning of ripening (fruits should not be picked, if however, picked, it should be allowed to ripen before marketing) and group 3 (firmness 60-69) - optimal harvest time (fruit is optimal stage of harvest and marketing), which means that cultivars 'Carpatin', 'Roman', 'Sarmatic', 'Tita' and 'Tuleu timpuriu' would have left a few days and then harvested.

On other criteria, namely fruit weight and soluble solids content, it can be said that all studied varieties are suitable for fresh consumption.

5. References

1. Branişte N., Budan S. Butac Mădălina, Militaru Mădălina, 2008. Quality of cultivars range for the major fruit species freshly marketed in Romania. ICDP Piteşti Mărăcineni. The International Workshop on Sustainable Fruit Growing and Use of Urban Sludge as Fertilizer for Fruit Trees. Ed. INVEL Multimedia.

2. Botu I., Botu M., 1997. Metode şi tehnici de cercetare în pomicultură. Ed. Conphys, Vâlcea, pg. 234-246.

3. Butac Mădălina, Bulgaru Liliana, 2001 – Rezultate parţiale privind comportarea unor hibrizi de perspectivă la prun sub aspectul calităţii fructelor. Buletin ştiinţific, nr.65 (21), ICPP Piteşti-Mărăcineni.

4. Butac Mădălina, Militaru Mădălina, Budan S., Nicolae Silvia, Nicola Claudia, 2009. Fruit quality of some plum cultivars grown in Maracineni, Arges. Lucrările Simpozionului – Mediul şi Agricultura în regiunile aride (prima ediţie), Staţiunea de Cercetare – Dezvoltare pentru Pomicultură Constanţa şi Universitatea Ovidius Constanţa – Facultatea de Ştiinţe ale Naturii şi Ştiinţe Agricole. Ed. Estfalia, Bucureşti, pg. 235-241. ISBN 978-973-7681-68-3.

5. Cociu V., Botu I., Minoiu N., Pasc I., Modoran I., 1997. Prunul. Editura Conphys: 165-171, Valcea, Romania.

6. Nicolae Silvia, Nicola Claudia, Paul-Bădescu A., Pârvan Camelia, Jugănaru Elena, Fabritius K., Copoiu Oana, Batalu Florentina, Drăguşanu Mihaela, 2008. Principiile nutritive din fructe şi importanţa lor pentru sănătatea umană. În: „Pomicultura durabilă – de la genotip la protecţia mediului şi sănătatea umană". Editura Estfalia, Bucureşti, pg. 377-401.

7. Planton G., 1995. Cerise: un code coleur puor ameliorer la qualite a la recolte. Infos-CTIFEL 112: 38-41.

8. Sekse L., Wermund U., 2008. Fruit flesh firmness in two plum cultivars: comparison of two penetrometers. Proceedings of the IXth International Symposium on Plum and Prune Genetics, Breeding and Pomology, Palermo, Italy. Acta Horticulturae 874, pg. 119-124.

9. Vangdal E., Flatland S.B., 2008. Criteria for picking plums (Prunus domestica L.) at the optimum maturity stage for the fresh fruit market. Proceedings of the IXth International Symposium on Plum and Prune Genetics, Breeding and Pomology, Palermo, Italy. Acta Horticulturae 874, pg. 125-130.

Tables and figures

Fig. 1. Colour chart

Fig. 2. Konica Minolta CR 400 chromameter

Fig. 3. Penetrometer Qualitest HPE

Fig. 4. Digital refractometer

Tabel 1. Colour appreciated: visual, with colour chart and with Konica Minolta chromameter

No.	Variety	Visual colour	Colour chart CTIFL	Colour parametters (*L, a, b*) Konica Minolta		
				L*	a*	b*
1	Alina	Light blue	4	29,26 a	8,21 a	+0,61 a
2	Carpatin	Blue brown	4	24,76 a	4,70 ab	-0,90 ab
3	Pitestean	Dark blue	6	28,67 a	2,35 b	-4,99 b
4	Roman	Reddish	4	22,22 a	7,32 a	+1,21 a
5	Sarmatic	Blue	5	22,54 a	6,05 a	+0,35 a
6	Tita	Blue	5	27,59 a	4,94 ab	-2,94 ab
7	Tuleu timpuriu	Light blue	4	26,87 a	5,48 ab	-0,76 ab
Average				25,99	5,58	-1,06
Standard deviation				4,18	2,37	2,86

(Duncan's multiple range test - P≤0.05)

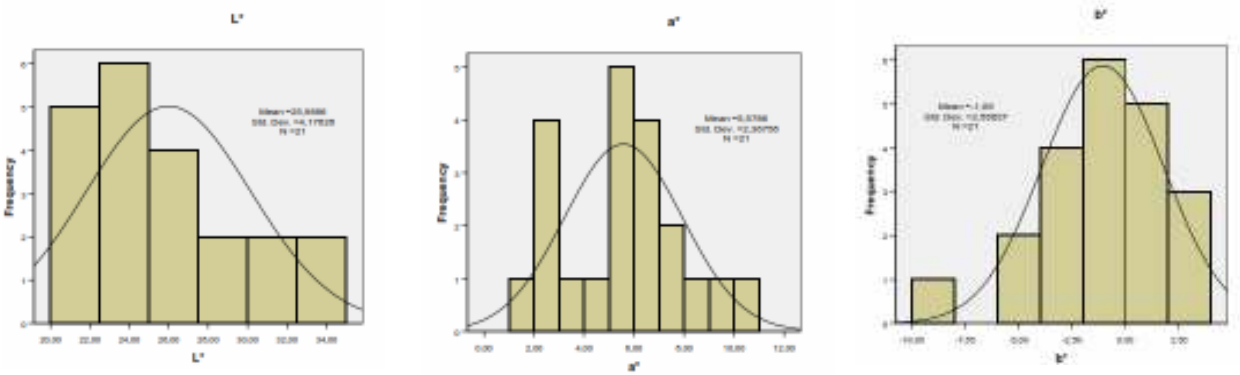

Fig. 5. Histogram of CIE L*a*b* colour scale

Table 2. Fruit firmness assessment using non-destructive penetrometer Qualitest

No.	Variety	Data of harvest	Firmness HPE units (N/0.10 cm^2)	Firmness class
1	Alina	24.07	64,97 a	3
2	Carpatin	24.07	70,57 a	2
3	Pitestean	24.07	62,70 a	3
4	Roman	24.07	72,10 a	2
5	Sarmatic	24.07	70,83 a	2
6	Tita	24.07	71,57 a	2
7	Tuleu timpuriu	24.07	72,23 a	2
Average			69,60	
Standard deviation			7,82	

(Duncan's multiple range test - P≤0.05)

Table 3. Firmness class (after E. Vangdal, 2008)

Clasa de fermitate	Thresholds	Maturity stage	Picking and marketing information
1	>80	Immature	The fruit not to be picked
2	70-79	Slightly mature	The fruit should not be picked. If picked, it should be allowed to ripen before marketing
3	60-69	Tree ripe	Optimum maturity stage for picking
4	50-59	Eating ripe	The fruit should be immediately picked and marketed
5	<50	Overripe	The fruit are overripe, should be discarded. Not to be marketed

Immature

Beginning of maturation

Optimum moment of maturation

Optimum moment of consumption

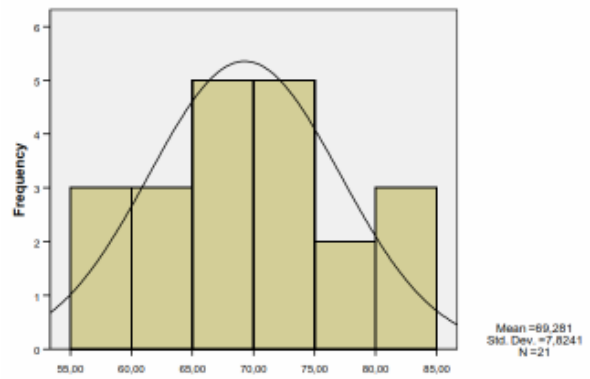

Fig. 6. Histogram of fruit firmness

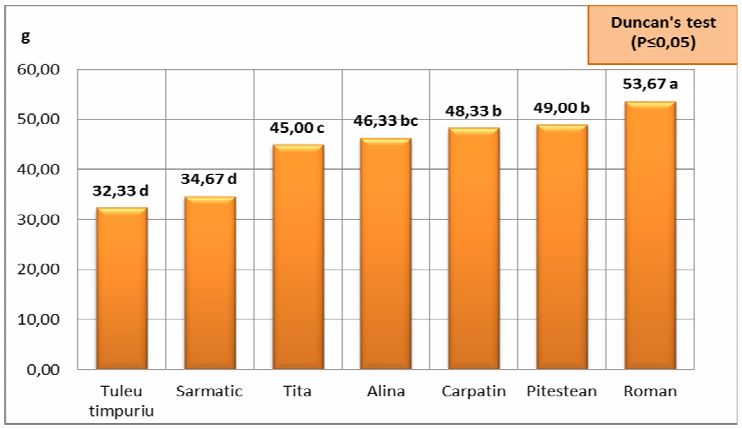

Fig. 7. Fruit weight at varieties studied

Fig. 8. Histogram of fruit weight

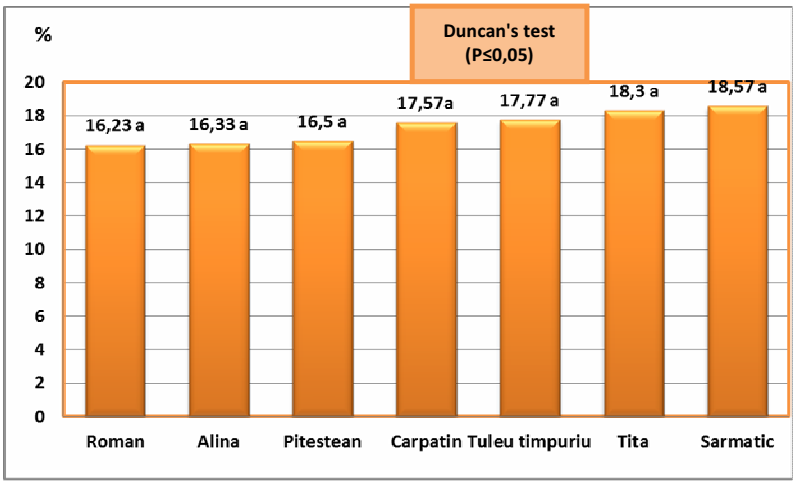

Fig. 9. Fruit soluble solids content at varieties studied

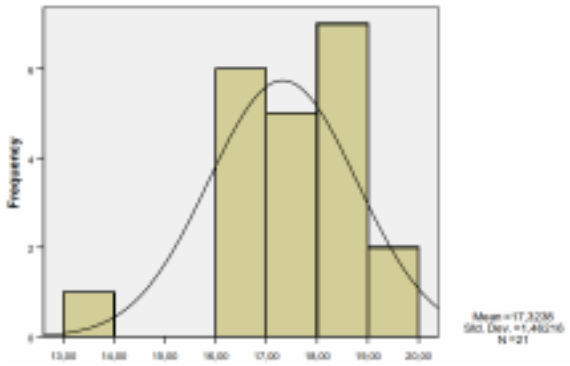

Fig. 10. Histogram of soluble solids content