

EVOLUTION OF SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE MYROBALAN PLUM FRUITS (*Prunus cerasifera* EHRH.) DURING THEIR GROWTH AND RIPENING

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ABSTRACT. *Fruits of six semi-cultivated genotypes of myrobalan plum from Mehedinti county, Romania were studied during their growth and ripening in order to determine the evolution of their chemical and physical characteristics. Thus, the main physical properties (fruit linear dimensions, weight, volume and the specific weight, size index, shape index) were determined in addition to dry matter (%), soluble solids (%), total sugar content as well as titratable acidity of fruit. During growth and ripeness of myrobalan plums their physical characteristics vary within different limits and in certain patterns depending on the dominant characteristic. Thus, the fruit dimensions have an obvious growth from the formation of the fruit until the 90% of final size growth whereas, during ripeness, fruits grow in a much slower rhythm. Fruits ranged values of the dry matter content between 20.64% (Vargati and Valea Balacenu) and 15.11% (Tesitu). The same increasing trend can be seen when dealing with the content in total soluble solids (highest value at full ripeness stage 20.34% in Valea Balaceanu village) and total sugar (highest value at full ripeness stage 18.96 g/100 g fw in Valea Balaceanu village).*

KEY WORDS: *myrobalan plum, genotypes, growth and ripening, phenological stages.*

INTRODUCTION

Prunus cerasifera, also called myrobalan plum, is a plant species of the genus *Prunus*, native to central and eastern Europe, southwestern and central Asia. In our country it is widespread as a wild species, often as protection curtains and for the fixing of the eroded shores and sometimes even the ravines, because they form several sprouts from the root. In Romania there are regions where only a few tree species can be grown as such there is a relatively low assortment of fruit for the population. The myrobalan plum (*Prunus Cerasifera* EHRH.) is a more rustic species that grows almost everywhere, grows more regularly than plum, have a very large yield, of course the vast majority of inferior quality, yet usable for fresh and canned food. There are years when other species have very low production and canning factories are forced to use myrobalan plum. The myrobalan (*Prunus cerasifera* EHRH) also has other attributes due to that it is one of the most widespread rootstocks of our apricot and peach nurseries. Apart from specialists, there are few consumers who know that in romanian nurseries 99% of the plums, 40-50% of the apricots and peaches are grafted on the myrobalan plum. The myrobalan plum is also useful for setting up protective curtains. Myrobalan fruits are rich in sugars, pectins, vitamins (C, PP, B1 and B2), carotene, organic acids (especially malic and citric acid), minerals (potassium, sodium, calcium, magnesium, phosphorus and iron) being used for medical purposes. Due to its higher pectin content than apples, myrobalan fruits provides better gelification, a more beautiful color, being used for gelled products manufacturing in food industry (Istrate 2007). Most studies on this species (Milutinovic and Nikolic 1994; Liu et al. 2008; Lei et al. 2007; Ayanoğlu et al. 2007; Lepsis et al. 2004; Horvath et al. 2011; Sitarek and Bartosiewicz 2011) were carried out on the phenotypic variability, the genetic structure and its influence as well as the rootstocks on the productivity and quality of fruits of other species such as apricots and peaches. Guizhi et al. (2007) analyzed phenotypic diversity of wild *Prunus cerasifera* EHRH. and the morphological characters of the elite strain from Yili, Xinjiang, China. Local semi-cultivated myrobalan plum genotypes can be used as a remarkable genetic base and a source of germplasm for development of new cultivars like 'Uriășe de Sibiu' that stands out by its commercial aspect, good taste and tolerance to PPV, being recommended in breeding programs and as an extension in commercial plantations in Romania (Butac et al. 2013). The range of total

phenolic content of Myrobalan plums is 1.34 to 6.11 g/kg fresh weight (FW), and anthocyanin content in fruit peel is from 1.93 to 19.86 g/kg peel, the purple myrobalan plum could be developed as a resource of fruit drinks or being used as the resource to extract natural pigments (Wang et al. 2012).

Present paper is a study regarding the variation of qualitative parameters of the myrobalan plums of some semi-cultivated genotypes from some villages of Mehedinti County, Romania during their growth and ripeness.

MATERIAL AND METHOD

Plant material

The study included six semi-cultivated genotypes of myrobalan plum trees (*Prunus cerasifera* EHRH.) from some villages located in the commune of Greci Mehedinti County respectively: Blidaru, Dutesti, Biltanele, Tesitu, Vargati and Valea Balaceanu. The commune of Greci is situated in the eastern part of Mehedinti County on the Strehaia platform, in the Motru River basin and on the parallel of 44 degrees and 30 min at an altitude of 200-300 meters. A commune with colinar relief, adjacent to the Motru River course, Greci holds geographical elements of hill with rough terrain. The commune comprises the villages of: Greci, Baltanele, Blidaru, Salatruc, Valea Petrii, Visina.

From the geological point of view, the territory of the commune is found on the geological map of the county in an area with formations of Inferior Levantin, Dacian and Pontian. In this area as well as in the hilly area there are very widespread neozoic sedimentary deposits, formed mainly by sands, clays and gravel, with frequent fossil nests. A profile in the Strehaia area has the following sedimentation compositions: up to 150 m sand and clay, up to 200 m charcoal, up to 400 m conglomerates with sandy bedrocks, and up to 1000 m sandy bedrocks and compact bedrocks. The climate is temperate continental with submediterranean influences. The average annual air temperature in the Piemont of Strehaia-Motru and up comes to 8-9 degrees Celsius. The largest quantity of precipitation is liquid, with annual values of 800-900 mm. The trees are located in private households and their production is mainly harnessed in the form of paste to make the soup sour or by distillation in order to obtain spirits. Fruit samples have been taken from the marked trees during their growth and ripeness

phases. Fruit samples were taken in three phenological stages respectively: fruit set, 90% of final size (in green) and full ripeness.

Analytical methods

Chemical analyzes and physical determinations were performed on the fruits samples in order to establish their quality. The variation of these parameters was observed during the three phenological stages. Thus, the main physical properties of fruit were determined: fruit linear dimensions (width, thickness, length), weight, volume, size index, shape index and the specific weight. Concerning the chemical analyses, were determined: dry matter content (%), total soluble solids (%), total sugar content as well as titratable acidity of the fruits. For carrying out the physical determinations of each variant were analyzed 50 fruit after which the arithmetic mean of the determinations was calculated. Fruit linear dimensions (length, L; width, W; thickness, T) were determined with a Luthier digital caliper manufactured by Stewart-MacDonald (USA) and the results were expressed as mm. Average fruit weight (W, g) was determined by individual weighing on an analytical scale model ABT 320-4M manufactured by Kern (Balingen, Germany). Size index was calculated using the formula: $(L+T+W)/3$ and shape index using the formula L/W . The fruit volume (V) was determined using a volume cylinder operating based on Archimedes principle and specific weight was calculated using the formula: W/V . The percentage of total dry matter was determined by removing water from the sample in an oven at 105°C. Soluble solids content was measured with a digital refractometer (Hanna Instruments, Woonsocket, USA) in the juice pressed from the whole fruit, the results being expressed as percentages; the total sugar content was determined by the School method and the results were expressed as $g \cdot 100 g^{-1}$ fresh matter. The titratable acidity was determined by titration of a known amount of water extract of fruits with 0.1 N NaOH using phenolphthalein as indicator and it was expressed as g malic acid/100 g fresh matter.

RESULTS AND DISCUSSIONS

The variation of the physical properties of cherry plums

The obtained results regarding physical characteristics of myrobalan plums fruits are presented in table 1. The main physical properties of myrobalan

plumswere determined from the variants used on vegetation phases, respectively: dimension, individual average weight, volume, specific weight. At the same time the index of size and the index of shape were calculated. The obtained results are shown in table1. From the presented data it can be noticed that during growth and ripeness of myrobalan plums their physical characteristics vary within different limits and in certain patterns depending on the dominant characteristic. Thus, the fruit dimensions have an obvious growth from the formation of the fruit until the 90% of final size growth whereas, during ripeness, fruits grow in a much slower rhythm.

Table 1A. Physical characteristics of the myrobalan plums in the selected genotypes.

Determination/Phenological stages	Fruit set	90% of final size (in green)	Full ripeness
Blidaru village			
Width (mm)	12.53±2.356	19.21±3.842	18.70±3.553
Thickness (mm)	11.81±2.015	18.67±3.547	18.37±3.204
Length(mm)	15.75±2.835	20.35±4.07	19.54±3.712
Weight (g)	1.67±0.317	4.72±0.755	4.29±0.686
Volume (cm ³)	1.58±0.301	4.00±0.612	4.28±0.684
Size index	13.36±2.672	19.41±3.493	18.87±3.585
Shape index	1.25±0.237	1.05±0.147	1.04±0.176
Specific wieght (g/cm ³)	1.05±0.189	1.18±0.153	1.00±0.132
Dutesti village			
Width (mm)	9.43±1.601	20.73±4.01	20.89±3.760
Thickness (mm)	8.41±1.513	19.81±3.763	19.59±3.526
Length(mm)	12.32±1.971	22.77±4.331	19.52±3.701
Weight (g)	0.85±0.133	5.56±1.01	4.99±0.948
Volume (cm ³)	0.96±0.142	5.50±0.935	6.6±1,188
Size index	10.05±1.507	21.10±4.035	20.00±3.789
Shape index	1.30±0.208	1.09±0.186	0.93±0.139
Specific wieght (g/cm ³)	0.88±0.123	1.01±0.151	0.75±0.105
Biltanele village			
Width (mm)	11.32±1.924	17.31±2.842	21.60±4.102
Thickness (mm)	10.79±1.942	16.93±3.216	20.79±3.948
Length(mm)	15.22±2.587	19.02±3.419	23.58±4.707
Weight (g)	1.50±0.239	3.57±0.606	6.28±1.067
Volume (cm ³)	1.65±0.280	3.40±0.544	8.10±1.377
Size index	12.44±2.239	17.75±3.543	21.99±4.379
Shape index	1.34±0.227	1.09±0.196	1.09±0.793
Specific wieght (g/cm ³)	0.91±0.145	1.05±0.178	0.77±0.138

Table 1B. Physical characteristics of the myrobalan plums in the selected genotypes.

Determination/Phenological stages	Fruit set	90% of final size (in green)	Full ripeness
Tesitu village			
Width (mm)	12.27±2.208	20.88±4.169	22.64±4.301
Thickness (mm)	11.20±2.128	19.85±3.966	21.49±4.296
Length(mm)	15.07±2.863	21.15±3.807	22.90±4.567
Weight (g)	1.55±0.262	5.03±0.903	6.38±1.212
Volume (cm ³)	1.52±0.273	5.10±0.877	9.6±1.822
Size index	12.84±2.311	20.62±3.915	22.34±4.356
Shape index	1.22±0.216	1.02±0.193	1.01±0.179
Specific wieght (g/cm ³)	1.01±0.161	0.98±0.1489	0.66±0.122
Vargati village			
Width (mm)	12.52±2.378	17.48±3.321	21.24±4.035
Thickness (mm)	11.25±1.912	16.83±3.186	20.94±3.978
Length(mm)	14.94±2.689	17.47±3.289	21.43±4.284
Weight (g)	1.54±0.261	3.33±0.566	5.82±1.045
Volume (cm ³)	1.42±0.241	3.50±0.627	8.28±1.403
Size index	12.90±2.322	17.25±3.277	21.19±4.223
Shape index	1.19±0.211	0.99±0.189	1.00±0.148
Specific wieght (g/cm ³)	1.06±0.190	0.95±0.174	0.70±0.126
Valea Balaceanu village			
Width (mm)	12.46±2.289	17.82±3.482	21.80±4.258
Thickness (mm)	11.21±2.108	17.29±3.339	21.50±4.189
Length(mm)	15.42±2.914	18.72±3.691	21.76±4.228
Weight (g)	1.59±0.243	3.74±0.627	6.31±1.115
Volume (cm ³)	1.88±0.295	3.90±0.578	9.08±1.513
Size index	13.03±2.289	17.94±3.272	21.08±4.111
Shape index	1.23±0.212	1.05±0.178	0.99±0.129
Specific wieght (g/cm ³)	0.84±0.133	0.95±0.161	0.69±0.110

It is known that there is no distinct limit between the end of the growth period and the start of ripeness, these processes going together for a short period of time, fact which is proven by the obtained data. However the obtained data regarding the dimensions of fruits at full ripeness are according with the previous studies (Cosmulescu et al. 2018). Still Saridaş et al. (2016) found bigger dimensions for myrobalan plums grown in Hatay Province, Turkey. As for the shape of fruit, the presented data shows that at fruit set, it has a round-oval shape with a supraunitary shape index, while

during ripeness the shape changes to round. However, the shape variations of myrobalan plums are more obvious at the fruit set and during growth and ripeness they become insignificant. Liu et al. (2008) mentioned also that the shape of the fruit is mainly rotundity. The weight of the fruit has grown during the entire period of growth and ripeness. Saridaş et al. (2016) found the same pattern of variation for fruits grown in Turkey. The growth rate of the fruit weight has been higher during ripeness than growth period because of the beginning of the synthesis of chemical compounds with large molecular weight. The same pattern of variation has been observed regarding the volume of the fruit. Concerning the specific weight of myrobalan plums it can be observed that it presents maximum supraunitary values at the 90% of final size of the fruit and the start of ripeness, after which it decreases, reaching even lower values than at the fruit set. The same variation trends have been observed at all the studied genotypes. However, there have been noticed differences among genotypes concerning the physical properties of myrobalan plums. Thus, the highest weight of fruit has been observed in the local genotype of Tesitu (6.31 g) followed by Valea Balaceanu (6.38 g) and Vargati (5.82 g). The lowest values have been found in the local genotype of Blidaru (4.29 g) and Dutesti (4.99 g). We have also noticed that the local genotype which had the largest fruit had the lowest values of specific weight ($0.6\text{g}/\text{cm}^3$ - Tesitu; $0.69\text{g}/\text{cm}^3$ - Valea Balaceanu)

The variation of the chemical compounds of myrobalan plums during growth and ripeness

The data regarding the main chemical compounds of the fruit during growth and ripeness are shown in table 2.

From the presented data we can see that in all the studied local genotypes the water content of fruit decreases during growth and ripeness, the highest being at the formation of fruit. The water content of fruit is inversely proportional with their total dry matter. As a consequence, during growth and ripeness the dry matter content increases, the highest accumulation of spare substances being at ripeness. Thus, at ripeness, depending on the local genotype, fruit ranged values of the dry matter content between 20.64% (Vargati and Valea Balacenu) and 15.11% (Tesitu). These variation limits of the dry matter content ripeness proves the feeding and nutritious value of these fruit which have hardly been studied until now. The same increasing trend can be seen when dealing with

Table 2. The variation of the chemical composition of myrobalan plums in the selected genotypes.

Content	Fruit set	90% of final size (in green)	Full ripeness
Blidaru village			
Dry matter (%)	8.93±1.593	12.84±2.311	15.75±2.837
Soluble solids (%)	5.3±0.910	11.8±2.11	13.25±2.352
Total sugar (g/100gfw)	2.89±0.502	7.32±1.327	11.08±2.105
Titrateable acidity (g Malic acid / 100g fw)	1.7085±0.294	3.7855±0.681	2.2780±0.410
Dutesti village			
Dry matter (%)	9.59±1.822	14.73±2.652	20.36±4.068
Soluble solids (%)	6.3±1.134	11.12±1.890	17.82±3.385
Total sugar (g/100gfw)	3.11±0.559	8.12±1.461	15.27±2.901
Titrateable acidity (g Malic acid / 100g fw)	1.742±0.296	3.8190±0.649	2.948±0.530
Biltanele village			
Dry matter (%)	9.60±1.728	14.14±2.686	19.34±3.868
Soluble solids (%)	5.5±0.935	10.71±1.927	14.49±2.696
Total sugar (g/100gfw)	3.04±0.516	7.47±1.419	11.89±2.140
Titrateable acidity (g Malic acid / 100g fw)	2.3785±0.451	3.3835±0.608	2.4790±0.471
Tesitu village			
Dry matter (%)	9.62±1.731	12.57±2.388	15.11±2.870
Soluble solids (%)	5.45±0.981	9.72±1.935	14.95±2.840
Total sugar (g/100gfw)	3.19±0.608	7.62±1.447	12.38±2.352
Titrateable acidity (g Malic acid / 100g fw)	1.943±0.369	3.7520±0.751	3.0150±0.572
Vargati village			
Dry matter (%)	9.77±1.854	13.55±2.702	20.64±4.123
Soluble solids (%)	5.8±1.101	11.10±2.164	19.34±3.539
Total sugar (g/100gfw)	3.56±0.637	8.29±1.517	17.04±3.118
Titrateable acidity (g Malic acid / 100g fw)	2.3450±0.415	3.5845±0.643	3.2495±0.588
Valea Balaceanu village			
Dry matter (%)	9.29±1.792	12.60±2.481	20.64±4.086
Soluble solids (%)	5.98±1.058	9.9±1.900	20.34±4.006
Total sugar (g/100gfw)	3.65±0.654	7.98±1.484	18.96±3.792
Titrateable acidity (g Malic acid / 100g fw)	1.7755±0.344	2.7470±0.527	2.2495±0.420

content in total soluble solids (highest value at full ripeness stage 20.34% in Valea Balaceanu village) and total sugar (highest value at full ripeness stage 18.96 g/100 g fw in Valea Balaceanu village). Saridaş et al. (2016) found lower levels of total soluble solids (13,0%) at full ripeness stage. Thus it can be said that the highest proportion of the soluble solids is represented by sugars, which renders the pronounced sweet taste of fruit at maturity. The high content of sugar makes this sweet fruit easy to process both by fermenting processes (alcoholic fermentation), for concentrated products (paste, jam), sterilized cans with a small amount of added sugar, and by dehydration. At the same time it can be seen that this fruit has high acidity manifested since the formation of fruit. During growth their acidity increases up to a maximum registered at the 90% of final size and the start of ripeness (3.8190 g malic acid/ 100 g fw at 90% of final size Dutesti), the lowest value being found in the fruit harvested in Valea Balaceanu (2.7470 g malic acid/ 100 g fw at 90% of final size). During ripeness titratable acidity decreases within relatively small limits same pattern being described by Kim et al. (2015). Titratable acidity at total ripeness it represents relatively high values compared to other fruit (3.2495 g malic acid/ 100 g fw. at total ripeness, Vargati; respectively, 2.2780 g malic acid/ 100 g fw. at total ripeness, Blidaru). Although myrobalan plums have high acidity at total ripeness, it is hidden by their high content of sugars.

CONCLUSIONS

As a rustic species, the myrobalan plum tree can be found almost everywhere, yields fruit in a more regular manner than the plum tree, gives very large productions, most of them of inferior quality of course, but it is still usable for fresh consumption and preserved food. Although considered fruit without special feeding or nutritious value and not given too much attention, the myrobalan plums turn out to have high energetic value. Their chemical composition at consumption maturity, with a high content of soluble solids and sugars especially, makes this fruit valuable from the feeding point of view. Thus, myrobalan plums can be processed at ripeness as fermented or distilled alcoholic drinks as well as concentrated products (paste, jam), sterilized cans with small quantities of sugar added during the manufacturing process, or dehydration. Due to the high acidity of fruit which gives the characteristic sour taste, at the cessation of fruit growth the

myrobalan plumscan be used to make different food products sour (soups, salad dressings etc). It is thus proved that this species should be studied more not only concerning its function as rootstock but also concerning the special quality of fruit and the possibilities of processing them.

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