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RESEARCH REGARDING THE INFLUENCE OF LOCAL CONDITIONS ON SEVERAL QUALITY INDICATORS FOR APPLES

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Abstract

Apple is one of the most important fruit growing species from the northern hemisphere. Fruit quality is important for capitalization, which is why technologists are trying to ensure, using technology, the best possible conditions to produce qualitative apple fruits. The current research presents a comparison of fruit quality for four varieties: 'Florina', 'Generos', 'Red Topaz' and 'Redix', cultivated in three areas: Pitesti, Bucharest and Moara Domnească. Fruit quality was influenced by the culture area, but also largely by the climatic year. Fruit size had values within the limits of each variety for all three areas, but the location had a different influence on this parameter. Dry soluble substance had higher values recorded for the varieties 'Florina' and 'Redix' cultivated in Bucharest area, while the varieties 'Generos' and 'Red Topaz' for Pitesti area. Fruit firmness was better for the fruit obtained in Pitești area (hilly area), compared to the other two areas, Bucharest and Moara Domnească (lower areas), while the content in anthocyanins and polyphenols was influenced more by the culture conditions than by the varieties' characteristics.

Key words*: fruit quality, fruit weight, biochemical characteristics.*

INTRODUCTION

Apple (*Malus domestica* L.) is one of the dominant fruit growing species in the northern hemisphere, the area and obtained production place the species amongst the top ones (Stănică et al., 2003). The quality of apple fruit is important in order to ensure the best possible capitalization and satisfying economical results. Fruit quality is a variety characteristic, influenced by the genetic traits, but it largely depends on the culture technology applied and the pedo-climatic conditions from the culture area (Chira and Beceanu, 2003). The plant management system (Tustin et al., 2022) and the degree of fruit exposure to light influence the coloring and accumulation of active principles through pigment synthesis (Hoza, 2000). The pigment accumulation at epicar level is conditioned by the illumination degree (Delgato, 2014) and especially by the thermal amplitude between day and night from the culture area before harvest (Curry, 1997; Lakatos et al., 2012). Recent research related to pigment synthesis at epicar level also highlighted a series of genetic mechanisms involved in this process (Chen et al., 2021; Ding et al., 2021). Soil maintenance system can influence the quality, the soil maintained grassy ensures more colorful fruits compared to the worked soil (Bărăscu et al., 2018; Ilie et al., 2017; Pantea 2012). Weather conditions, especially times with small amounts of rainfall but on longer periods, affect the fruit production, influencing the development of diseases with negative effects on fruit quality (Bui et al., 2021). The grafting combination and the rootstock used influence both tree precocity and fruit quality (Bărăscu et al., 2016; Hoza et al., 2020; Macedo et al., 2012). Ensuring minerals at soil level within the normal quantity and distribution during the vegetation period ensures a normal fruit growth and reaching the biological potential at a variety level (Ilie et al., 2018).

MATERIALS AND METHODS

Research was conducted during 2015-2017, on fruits obtained from 3 different locations: the teaching field of the Faculty of Horticulture Bucharest, Moara Domnească farm and ICDP Pitești - Mărăcineni. Four varieties with genetic resistance were used: Florina, Generos, Redix and Red Topaz, using for measurements 10 fruit of each variety, while the measurements

were made at the same moment of each year. Biometric measurements were made related to fruit dimensions using the caliper (height, large and small diameter), and using them the shape index If = H/D (H= fruit height; D = large fruit diameter) and size index Im = (H+D+d)/3 (d = small fruit diameter) and average weight were calculated. The firmness of the apples was determined using a piston of 1.1 cm diameter (Bessemans, 2016; Both et al., 2017; Rizzolo, 2010) of an electronic penetrometer Turoni TR and the results were expressed in kg/cm^2. The total soluble solids content of the apples juice was obtained with refractive device Kruss DR301-95 (% Brix) (Muresan et al., 2014).

RESULTS AND DISCUSSIONS

Fruit dimensions fluctuated within rather low limits for the same variety between the 3 locations, which showed a quite good stability of the characteristics and that the conditions of the area were favorable for the apple (Table 1). For the variety Red Topaz, the fruit obtained in Pitești area were slightly bigger in terms of large diameter, which led to obtaining a shape index with a value lower than for the other locations. The small diameter had fluctuating values for the varieties Florina and Red Topaz, aspect that determined higher values for the size index for these varieties.

Table 1. Morphological indexes of fruit for some apple varieties, cultivated within 3 different locations

Variety	Location	Large diameter (mm)	Small diameter (mm)	Height (mm)	Shape index	Size index
Florina	USAMV Bucharest	73.65	63.39	69.40	0.94	68.81
	ICDP Pitești	75.62	72.55	62.27	0.82	70.14
	Moara Domnească	74.15	64.35	63.40	0.85	67.30
	Average	74.47	66.76	65.02	0.87	68.75
Generos	USAMV Bucharest	76.22	71.85	59.21	0.78	69.09
	ICDP Pitești	75.30	71.35	57.32	0.76	67.99
	Moara Domnească	75.21	70.23	58.32	0.77	67.92
	Average	75.58	71.14	58.28	0.77	68.33
Red Topaz	USAMV Bucharest	65.52	64.12	51.16	0.78	60.27
	ICDP Pitești	77.20	73.61	50.10	0.64	66.97
	Moara Domnească	66.22	64.12	50.65	0.76	60.33
	Average	69.65	67.28	50.64	0.73	62.52
Redix	USAMV Bucharest	70.30	67.29	68.45	0.97	68.68
	ICDP Pitești	70.53	67.62	71.15	1.00	69.77
	Moara Domnească	70.44	67.32	69.25	0.98	69.00
	Average	70.42	67.41	69.62	0.98	69.15

In what concerns average fruit weight during the 3 analyzed years, differences were recorded both between the locations and especially between the years when the measurements were made (Table 2). Thus, for the 3 varieties, Florina, Red Topaz and Redix, the year 2016 was better, the obtained fruit being larger than the ones obtained in 2015, when the fruit were the smallest. For the variety Generos, a slight increase from one year to another during research period.

The location had no uniform influence on the 4 varieties; the fruits obtained for Florina and Red Topaz were larger in the Pitești area, the Generos variety reacted better in the Moara Domnească area, while Redix scored better in Bucharest area. For all locations, fruit size had values within the variation limits of the varieties, the influence of the climatic year being obvious.

Fruit quality expressed through total dry substance content and firmness had different values both amongst the varieties, as it should have, but also amongst the same variety between the culture area (Table 3). Thus, regarding the content in soluble dry substance, for the Florina variety the highest value was recorded for the fruit obtained in Bucharest area, while the lowest value was recorded for Pitești area; in the case of Generos, fruit accumulated more substance in Pitești and less in Bucharest. Redix accumulated more dry substance in Pitești location and less in Moara Domnească, while Red Topaz reacted better to the conditions from Moara Domnească.

Table 2. Average fruit weight (g) depending on the production area

Variety	Locations	2015	2016	2017	Average	± St. Dev.
Florina	USAMV Bucharest	139.50	201.00	161.00	167.17	31.2103
	ICDP Pitești	162.00	194.00	170.00	175.33	16.6533
	Moara Domnească	172.00	180.00	157.00	169.67	11.6761
	Average	157.83	191.67	162.67	170.72	18.2987
Generos	USAMV Bucharest	145.00	179.00	168.00	164.00	17.3493
	ICDP Pitești	151.00	145.00	171.00	155.67	13.6137
	Moara Domnească	176.00	175.00	168.00	173.00	4.3588
	Average	157.33	166.33	169.00	164.22	6.1131
Red Topaz	USAMV Bucharest	182.00	154.00	137.00	157.67	22.7229
	ICDP Pitești	145.50	199.00	158.00	167.50	27.9866
	Moara Domnească	122.00	176.00	153.00	150.33	27.0985
	Average	149.83	176.33	149.33	158.50	15.4461
Redix	USAMV Bucharest	144.00	172.00	167.00	161.00	14.9331
	ICDP Pitești	158.00	170.00	132.00	153.33	19.4250
	Moara Domnească	138.00	172.00	162.00	157.33	17.4737
	Average	146.67	171.33	153.67	157.22	12.7119

Fruit firmness was better for the fruits obtained from 3 out of the 4 studied varieties in the Pitești area, which confirmed that this area ensures proper conditions for apple culture.

Table 3. Content in soluble dry substance and fruit firmness for some apple varieties depending on the production area

Variety	Location	Dried substance (%)	±St. Dev.	Firmness (kgf/cm^2)	±St. Dev.
Florina	USAMV Bucharest	13.9	2.7222	5.17	2.1501
	ICDP Pitești	11.53	2.2538	5.90	2.0663
	Moara Domnească	13.55	0.3535	5.10	1.5556
	Average	12.88	0.4284	5.68	2.0166
Generos	USAMV Bucharest	12.07	1.3219	5.23	1.3576
	ICDP Pitești	13.30	0.2000	5.60	1.2489
	Moara Domnească	13.20	0.0700	3.60	0.0800
	Average	12.79	0.6646	5.17	1.0016
Red Topaz	USAMV Bucharest	12.70	1.9000	4.80	1.4730
	ICDP Pitești	12.63	0.5773	5.33	1.6802
	Moara Domnească	13.90	1.2513	4.00	0.0070
	Average	12.71	0.984	4.94	1.5607
Redix	USAMV Bucharest	12.77	1.3051	4.77	3.0237
	ICDP Pitești	12.93	1.5373	4.70	1.8681
	Moara Domnească	11.15	1.9091	4.60	0.1414
	Average	12.58	1.0605	4.98	2.0678

The content in polyphenols and anthocyanins was influenced by the apple production area, amongst the same variety there were large differences recorded between the locations (Table 4). The highest average value for polyphenols content was obtained for the variety Florina, 1.14 mg/100 g f.p., with a maximum recorded for the fruit obtained in Pitești, 1.38 mg/100 g f.p. and a minimum in Moara Domnească 0.90 mg/100 g f.p. A similar situation was observed also for the variety Redix. In the case of Red Topaz and Generos, Bucharest area was better from this perspective, the values being obviously higher for Red Topaz with approx. 45% compared to the other two locations. The content in anthocyanins was higher for the fruits obtained in Pitești area, except for Generos for which the values were slightly higher for the fruit obtained in Bucharest and Redix for Moara Domnească area.

Table 4. Content in polyphenols and anthocyanins for some apple varieties cultivated in different areas

Variety	Location	Polyphenols		Anthocyanins	
		mg/100 g p.p.	± St. Dev.	mg/100 g p.p.	± St. Dev.
Florina	USAMV Bucharest	1.15	0.0006	0.22	0.1035
	ICDP Pitești	1.38	0.0001	0.40	0.1033
	Moara Domnească	0.90	0.1140	0.20	0.1140
	Average	1.14	0.0382	0.27	0.1100
Generos	USAMV Bucharest	0.92	0.0732	0.16	0.1100
	ICDP Pitești	0.43	0.0374	0.08	0.1226
	Moara Domnească	0.51	0.0412	0.12	0.0074
	Average	0.62	0.0506	0.12	0.0800
Red Topaz	USAMV Bucharest	1.44	0.1705	0.42	0.1114
	ICDP Pitești	0.80	0.1855	0.42	0.1042
	Moara Domnească	0.75	0.1211	0.41	0.1105
	Average	1.00	0.1590	0.42	0.1087
Redix	USAMV Bucharest	0.84	0.0071	0.30	0.0102
	ICDP Pitești	0.90	0.0045	0.30	0.1030
	Moara Domnească	0.75	0.2780	0.40	0.0278
	Average	0,83	0.0006	0.33	0.1035

CONCLUSIONS

Apple quality was influenced both by the variety and also by the culture area and climatic year. Fruit size had values within the biological limits of the variety, but for 3 out of the 4 studied varieties, the conditions in the Pitești area led to obtaining larger fruit.

Average fruit weight was influenced by the culture area, each variety having an area where it manifested better its biological characteristics.

Fruits obtained in the lower culture area generally had a higher content in soluble dry substance, while fruit obtained in Pitesti had a better firmness.

The content in polyphenols and anthocyanins was slightly higher for the fruit obtained in the hilly area.

REFERENCES

Bărăscu R., Hoza D., Bezdadea-Cătuneanu I., Naftănăilă M., Albulescu A., 2016. *Preliminary research regarding the grafting interstoch and soil maintenance influence on fruit quality for Pinova Variety.* Agriculture and Agricultural Science Procedia 10: 167-171

Bărăscu Radu, Dorel Hoza, Ligia Ion, Gheorghița Hoza, 2018, *Effects of grafting combinations on the fruit quality for the Pinova apple tree.* Scientific Papers, Series B, Horticulture, vol. LXII, p.55-58.

Bessemans N., Verboven P., Verlinden B.E., Nicolaï B.M., 2016. *A novel type of dynamic controlled atmosphere storage based on the respiratory quotient (RQ-DCA).* Postharvest Biology and Technology 115: 91-102.

Both V., Thewes F.R., Brackmann A., Anese R.O., Ferreirad.F., Wagner R., 2017. *Effects of dynamic controlled atmosphere by respiratory quotienton some quality parameters and volatile profile of Royal Gala apple after long-term storage.* Food Chemistry 215: 483-492

Bui T.A.T., Stridh H., Molin M., 2021. *Influence of weather conditions on the quality of'Ingrid Marie'apples andtheir susceptibility to grey mould infection,* Journal of Agriculture and Food: 58 .

Chen Zijing , Lei Yu, Wenjun Liu, Jing Zhang, Nan Wang, Xuesen Chen, 2021. *Research progress of fruit color development in apple (Malus domestica Borkh.)* Plant Physiology and Biochemistry, Volume 162, Pages 267-279.

Chira A., Beceanu D., 2003. *Tehnologia produselor horticole*, Editura Economică.

Delgado-Pelayo R., Gallardo-Guerrero L., Hornero-Méndez D., 2014, *Chlorophyll and carotenoid pigments in the peel and flesh of commercial apple fruit varieties*, Food Research International,Vol.65 No.Part B: 272-281 ref.48.

Ding Tiyu, Ruiping Zhang, Hengtao Zhang, Zhe Zhou, Chonghuai Liu, Mengmeng Wu, HuanWang, Haiqing Dong, Jihong Liu, Jia-LongYao, Zhenli Yan, 2021. *Identification of gene co-expression networks and key genes regulating flavonoid accumulation in apple (*Malus × domestica*) fruit skin.* Plant Science, Volume 304, 110747.

Hoza D., 2000. *Pomologie*, Ed. Prahova, Ploiesti.

Hoza Dorel, Radu Bărăscu, Liliana Bădulescu, Ioana Cătuneanu-Bezdadea, Ioannis Kotrotsios, 2020. *Research regarding the influence of rootstock on the production and fruit quality for the pinova apple variety.* Scientific Papers. Series B, Horticulture, Vol. LXIV, No. 1, 98-102.

Ilie Alina Viorica, Cristina Petrisor, Dorel Hoza, Viorel Oltenacu, 2017. *Influence of soil type on yield and quality of different apple cultivars.* Bulletin UASVM Horticulture 74(1):21-25

Ilie Alina Viorica, Cristina Petrișor, Dorel Hoza, 2018. *Effect of different amino acid foliar fertilizers on yield and fruit quality of 'Redix' apple cultivar.* Science Papers, Seria B Horticulture, vol. LXII, p.77-82.

Jua Zhiqiang , Yousheng Duana, Zhiguo Jub, 1999. *Effects Of Covering The Orchard Floor With Reflecting Films On Pigment Accumulation And Fruit Coloration In 'Fuji' Apples*. Scientia Horticulturae, Volume 82, Issues 1–2, Pages 47-56.

Lakatos L., Biniak-Pieróg M., Żyromski A., 2012. *Effect of night and day temperature on the cover colour and quality parameters of apple*. Journal of water and land development, No. 16 (I–VI): 23-28.

Macedo Tiago Afonso, Pricila Santos da Silva, Guilherme Fontanella Sander, Juliana Fátima Welter, Leo Rufato, Andreade Rossi, 2019. *Productivity and quality of 'Fuji Suprema' apple fruit in different rootstocks and growing conditions.* Scientia Horticulture, vol. 256, 108651.

Mureşan E.A., Muste S., Borşa A., Vlaic R.A., Mureşan V., 2014. *Evalution of physical-chemical indexes, sugars, pigments and phenolic compounds of fruits from three apple varieties at the end of storage period*. Bulletin UASVM Food Science and Technology 71(1): 45-50.

Pantea S. D., 2012, *Efectul diferitelor sisteme de lucrare a solului asupra calității și cantității producției de la mărul cultivat în sistem superintensiv*, Rezumat, teza de doctorat, Cluj-Napoca.

Rizzolo A., Vanoli M., Spinelli L., Torricelli A., 2010. *Sensory characteristics, quality and optical properties measured by time-resolved reflectance spectroscopy in stored apples*. Postharvest Biology and Technology 58: 1-12.

Stănică F., Branişte N., Ghena N., 2003. *Pomicultura generală,* Editura Invel Multimedia.

Ticha A., Salejda A., Hyspler R., Matejicek A., Paprstein F., Zadak Z., 2015. *Sugar composition of apple cultivars and its relationship to sensory evoluation. NaukaTechnologia Jakose* 4(101):137-150.

Tustin D.S. , K. C.Breen, B.M. van Hooijdonk, 2022, *Light utilisation, leaf canopy properties and fruiting responses of narrow-row, planar cordon apple orchard planting systems - A study of the productivity of apple,* Scientia Horticulturae, Volume 294, 110778.