

KIWI FRUIT PRELIMINARY CHARACTERIZATION OF SOME HYBRID GENOTYPES (*ACTINIDIA* SP.)

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Abstract

The paper presents the fruits characterization of four new kiwi hybrid genotypes and the effects of cold storage on postharvest fruit quality. After harvesting and during the storage period, different fruit characteristics including some mechanical properties were measured and evaluated in dynamics. The hybrid kiwifruits and other varieties of Actinidia sp. were produced in the experimental field established at the USAMV of Bucharest, in an organic orchard. The fruits were harvested starting with early of October and ended up at beginning of November. The fruit production was analyzed for each genotype and was expressed as total number of fruits per plant and yield per plant. At harvest, fruit quality indicators as fruit weight, shape index and some other characteristics (fruit firmness, soluble solids content) were analyzed. After harvesting, kiwifruits were stored in two different conditions. Every month, during the cold storage, the evolution of some fruit parameters: soluble solids content (SSC) and fruit firmness was studied. Besides that, at the consumption maturity, fruit content in ascorbic acid and in total dry matter were analyzed.

Key words: fruits, storage, flesh firmness, soluble solids, ascorbic acid.

INTRODUCTION

Kiwi (*Actinidia* sp.) is a new fruit species for Romania and the creation, testing and introduction of winter hardy genotypes, adapted to the local harsh climate conditions is a priority.

A common Italian-Romanian kiwifruit breeding program was initiated in 1993 and during the time, several interspecific hybrid genotypes were obtained (Zuccherelli, 1993, Stănică and Cepoiu, 1996).

Kiwifruits are appreciated for their taste and their highly nutritious level (Drummond, 2013). Moreover, the kiwifruits are characterized by a low calories content and high amount of biologically active compounds, including ascorbic acid (Plekhanova et al., 1940; Namestnikov et al., 1989).

There are many researches focused on the different varieties of *Actinidia* sp. concerning its health benefits, good storage life and possibilities of maintaining and controlling postharvest kiwifruit ripening (Burdon et al., 2004; Huang et al., 2004, White et al. 2005,

Stonehouse et al., 2013). Due the increased production of kiwifruits from all over the world, a very important aspect is applying the correct postharvest preservation technologies for assuring and maintaining nutritional quality, reduce damage and prolong shelf life (Liato et al., 2017).

For kiwifruit marketing, Cangi (2011) brought up that some of the most important factors are the following: the maturity level, sugar content, pulp color, size, mechanical defect, firmness etc.

Also, Lallu (1989) observed that the long fruit storage life has high economic importance, making possible the marketing of the fruits much later after their harvest season and the fruit quality is given by different parameters which express a complete picture of the fruit characteristics. Lallu (1989) mentioned that the optimum kiwifruit storage temperature to slow down the process of ripening is at 0°C.

According to White (2005), although different genotypes of one species may be genetically and morphologically similar, there can be noticed certain differences in characteristics

such as softening rates, flavor and capacity for storage. These differences could render one genotype more valuable than another in commercial production.

Based on these considerations, the aim of this study is to present the fruits characterization of some new kiwi hybrid genotypes and the effects of cold storage on postharvest fruit quality. After harvesting and during the storage period, different fruit characteristics were measured and evaluated in dynamics.

MATERIALS AND METHODS

Fruits sampling and preparation

At the University of Agronomic Sciences and Veterinary Medicine of Bucharest, in the Experimental Field of Faculty of Horticulture, was established an experimental plot with kiwifruit hybrid genotypes, besides other varieties of *Actinidia deliciosa*, *A. chinensis* and *A. arguta*.

In order to accomplish the aim of this paper four kiwifruit genotypes were used: R2P3, R2P6, R1P9 and R0P12.

The plants were grown on a T - bar trellis system, a micro spray irrigation system was used, and an organic orchard management was applied.

The fruits were harvested at the beginning of November. Harvesting moment was established, when the fruit flesh firmness was less than 7 kg force/cm². The fruit production was analyzed for each genotype and was expressed as total number of fruits per plant, yield per plant and yield per ha. At harvest, fruit quality indicators such as fruit weight, shape index and some other characteristics (fruit firmness, soluble solids content) were analyzed using the common laboratory techniques.

After harvesting, kiwifruits were stored in two different conditions: cold storage at 3°C and 95% humidity and controlled atmosphere at 1.5% oxygen, 1-2°C and 95% humidity.

After 4, 8, 12 and 16 weeks during the cold storage, the evolution of some fruit parameters was studied: soluble solids content (SSC) and fruit firmness. Besides that, at the consumption maturity, fruit content in ascorbic acid and in total dry matter were analyzed.

All the determinations and analyses were made in the laboratories of the Research Center for Studies of Food Quality and Agricultural Products.

Physicochemical analysis

The *yield of the genotypes* was expressed as number of fruits per plant and kilograms of fruits per plant.

Fruit weight (g/fruit) was measured by digital balance of accuracy of 0.001g.

Shape index was determined by measuring fruit length, longitudinal and transversal fruit diameter, using a caliper with 0.1 mm accuracy.

Fruit flesh firmness determined by measuring penetration force, was measured in two opposite cheeks of a sliced fruit, using an electronic penetrometer, equipped with a cylinder of 8 mm diameter. The results were expressed in kg/cm² (Chen, 2015; Mworira, 2012).

Soluble solids content (SSC) of the fruit juice was determined using a digital Krüss Refractometer DR301-95 (Yoon, 2005; Saei, 2011; Mureşan, 2014; Oltenacu, 2015) and the results being expressed in % Brix.

The *dry matter and water content* of the samples were determined by oven drying for 24 hours at 105°C using a UN110 Memmert oven. The method was used also by Moura (2005), Skupień (2006), Delian (2011), Corollaro (2014), Mureşan (2014), Ticha (2015).

Ascorbic acid content from kiwifruit samples was determined with HPLC – Agilent Technologies 1200 Series equipment. A ZORBAX Eclipse XDB-C18 (4,6x50 mm, 1,8µm) column with Rapid Resolution HT and a detector UV-DAD detection wavelength 220/30 nm, reference wavelength 400/100 nm, was used. Mobile phases were A= 99% (ultrapure water with H₂SO₄ up to 2,1 pH) and B= 1% (acetonitrile with 10% A). For each genotype, an average sample of 10 fruits was used and mixed into a Grindomix robot for a period of 10 seconds at a speed of 0,55 rpm. 1 g of fruit pulp was extracted in centrifuge tubes with 10 ml of water acidified with sulfuric acid to a pH of 2,1. Then the tube was incubated for 45 minutes at 4°C under dark conditions. After this process, the tubes were centrifuged for 1 minute at 1000 rpm to sediment the coarse part of the preparation. The samples were filtered

through a filter Agilent RC 0,2 μm . The injection volume was 2 μl , with 4 min post time, flow rate at 0,5 ml/min at 30°C in column compartment. The samples were analyzed in duplicate and were expressed in mg/100g. In order to perform the quantitative analysis of samples a calibration curve through injection of known concentration of standards (from 12.5 to 1000 $\mu\text{g/ml}$) was realized.

Statistical evaluation of the experimental data was performed by simple comparisons of mean values and standard deviation, calculated using incorporated function of Microsoft Excel.

RESULTS AND DISCUSSIONS

The fruits (represented in Figure 1) were harvested when the fruit flesh firmness was less than 7 kg force/cm² and at list 6-7 % Brix according to previous research. The initial physicochemical analysis, after harvesting time (fruit flesh firmness, soluble solids content) is presented also in Table 1.

The yield of the genotypes expressed as number of fruits per plant, kilograms of fruits per plant and tons per hectare are represented in Figure 2.

As reported in the graphic, the most productive selection was R2P3 followed by R0P12. The lowest production was obtained by R1P9. But, comparing the results with previous research, it should be taken into consideration that the plants were not maintained according to a commercial plantation, they are part of a selection experimental trial. In normal conditions on commercial orchards, the potential production must be higher.

The production expressed on tons per hectare was calculated for 5 m between the rows and 2.5 m between the plants per rows.

The average fruit weight and shape index are presented in Table 2.

The size of green kiwifruits ranged from small (46,2 g at R0P12) to large size (102,18 g at R1P9), while the yellowish fruit of the interspecific hybrid R2P6 was rather small in size with only 11,2 g (Table 1).

The pulp firmness of the selected hybrids, varied at the harvesting moment between 0.99 (R2P6) and 2.28 (R0P12) (Figure 3).

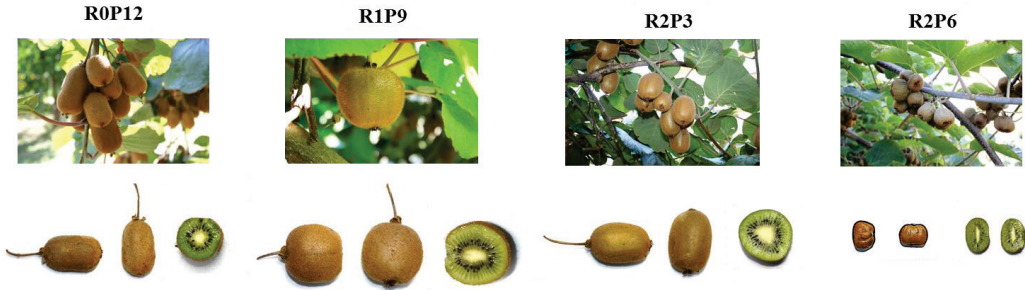


Figure 1. Studied kiwifruits genotypes at the harvesting time

Table 1. Physic-chemical characteristics of kiwifruit genotypes before storage

Genotype	Time of harvesting	Firmness (kg/cm ²)	Soluble solids content (% Brix)
R0P12	06.11.2017	2,28	11,33
R1P9	06.11.2017	1,32	13,54
R2P3	06.11.2017	2,27	10,96
R2P6	06.11.2017	0,99	15,34

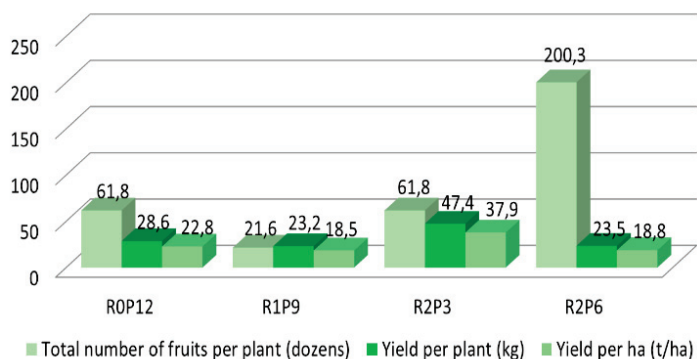


Figure 2. Fruit production of studied kiwifruit genotypes

Table 2. Average fruit weight and shape index

Genotype	Average fruit weight (g)	Shape index			
		Peduncle length (mm)	Fruit length (mm)	Longitudinal fruit diameter (mm)	Transversal fruit diameter (mm)
ROP12	46,2	39,2	57,0	34,9	57,3
R1P9	102,2	37,8	55,5	58,2	49,0
R2P3	88,7	45,5	64,1	53,5	44,0
R2P6	11,2	11,7	23,6	27,1	23,9

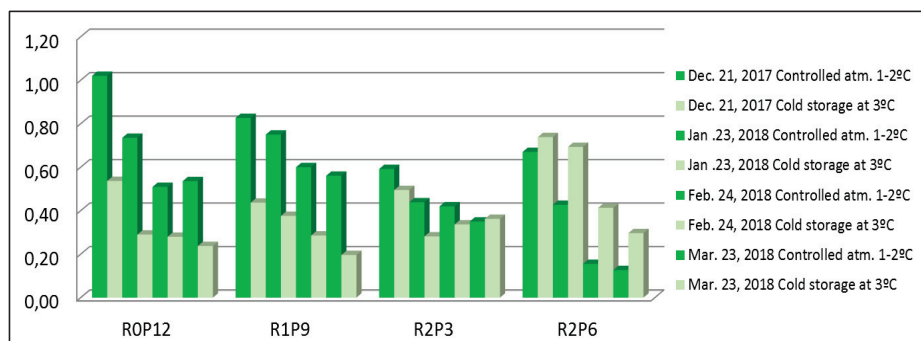


Figure 3. Evolution of fruit flesh firmness (kgf/cm²) for studied kiwifruit genotypes

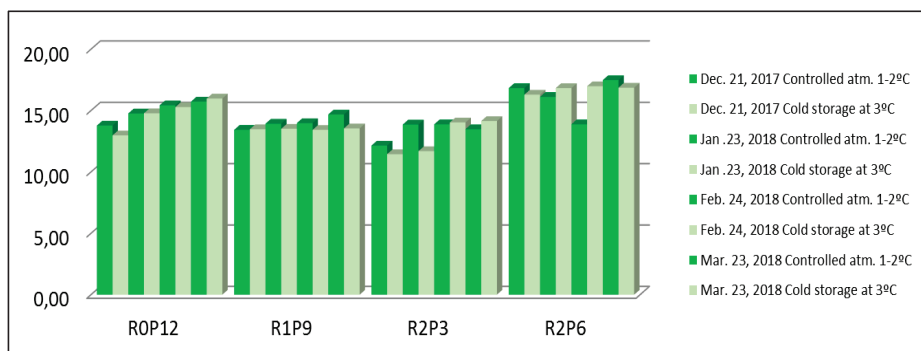


Figure 4. Evolution of soluble solids content (% Brix) for studied kiwifruit genotypes

For all genotypes throughout storage can be observed a significant increase in soluble solids content (Figure 4). Additionally, it can be observed that the fruits flesh firmness reduced from the initial moment (after harvesting time) (Figure 3).

The kiwifruits, after picking, during the post-harvest storage, continued the physiological development until they become suitable for consumption. At the beginning of consumption maturity, fruit analysis regarding soluble solids content, firmness (Table 3) and ascorbic acid were performed for each genotype (Figure 5).

Table 3. Physicochemical characteristics of kiwifruit genotypes at the beginning of consumption maturity

Genotype	Time of maturity consumption	Firmness (kg/cm ²)	Soluble solids content (% Brix)	Ascorbic acid content (mg/100 g)
R0P12	28.03.2018	0,54	15,7	45,04 ± 0,13
R1P9	28.03.2018	0,56	14,7	77,20 ± 0,85
R2P3	14.11.2017	0,59	12,5	56,07 ± 0,43
R2P6	14.11.2017	0,67	16,8	70,27 ± 3,72

Also, the percentage of the water and dry matter were determined (Table 4).

Table 4. Dry matter and water content of kiwifruit genotypes at the beginning of consumption maturity

Genotype	Dry matter content (%)	Water content (%)
R0P12	16	84
R1P9	19	81
R2P3	14	86
R2P6	19	81

The degree of flesh softening influences the life storage of kiwifruit. Krupa (2011) mentioned that kiwifruits were ready to eat when the flesh firmness reached less than 1,00 kg/cm².

Table 4 presents the fruit content in soluble dry matter, which varied from 14% to 19%. The lowest total dry matter content (14%) was registered in the fruits of R2P3 selection and the highest (19%) at was measured in R1P9 and R2P6 genotypes.

The ascorbic acid content, expressed in mg/100g fresh matter, had the values scaled between 45.04 (R2P3) and 77.2 (R1P9) (Figure 5).

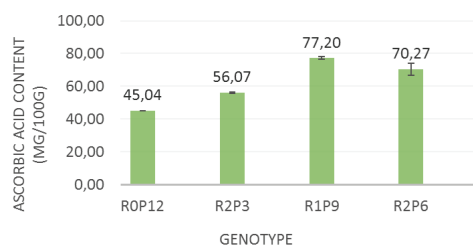


Figure 5. Ascorbic acid content (mg/100g) at the beginning of consumption maturity for studied genotypes

CONCLUSIONS

In order to accomplish the aim of this paper four kiwifruit genotypes were used: R2P3, R2P6, R1P9 and R0P12. The storage in rooms with controlled atmosphere influenced, as expected, fruit quality parameters. It can be noted that all varieties of samples did not have the same level of maturity at harvest, compared with normal conditions of cold storage. Because of that, R2P3 behaved much better during the four months of storage compared to the other genotypes, maintaining much better visual, organoleptic and economical properties. The highest amount of ascorbic acid content was determined for R1P9 - 77.20 ± 0.85 mg/100 g. In the case of soluble solids content, it was observed that R2P6 and R0P12 have the higher content - 16,8 % Brix and respectively 15,7 % Brix.

The most productive genotype was R2P3 followed by R0P12. R1P9 which formed the biggest fruits (102.2 g) and seems to be a very promising selection.

REFERENCES

- Burdon J., D. Mcleod, N. Lallu, J. Gamble, M. Petley, A. Gunson, (2004). Consumer evaluation of "Hayward" kiwifruit of different at harvest dry matter contents. *Postharvest. Biol. Technol.* 34, 245.
- Cangi R., E. Altuntas, C. Kaya, O. Saracoglu, (2011). Some chemical and physical properties at physiological maturity and ripening period of kiwifruit ('Hayward'). *Afr. J. Biotechnol.* 10, 5304.
- Chen H., Cao S., Fang X., Mu H., Yang H., Wang X., Xu Q., Gao H., (2015). Changes in fruit firmness, cell wall composition and cell wall degrading enzymes in postharvest blueberries during storage. *Scientia Horticulturae* 188, 44-48.
- Corollaro M. L., Aprea E., Endrizzi I., Betta E., Demattè M. L., Charles M., Bergamaschi M., Costa F., Biasioli F., Grappadelli L. C., Gasperi F., (2014). A combined sensory-instrumental tool for apple quality

- evaluation. *Postharvest Biology and Technology* 96, 135-144
- Delian E., Petre V., Burzo I., Bădulescu L., Hoza D., (2011). Total phenols and nutrients composition aspects of some apple cultivars and new studied breeding creations lines grown in Voinești area – Romania. *Romanian Biotechnological Letters* vol. 16, no. 6
- Drummond L., (2013). The composition and nutritional value of kiwi fruit. *Adv. Food. Nutr. Res.* 68, 33.
- Huang, H., Wang, Y., Zhang, Z., Jiang, Z., Wang, S. (2004). Actinidia germplasm resources and kiwifruit industry in China. *HortScience* 39, 1165–1172.
- Krupa T., Latocha P., Liwińska A., (2011). Changes of physicochemical quality, phenolics and vitamin C content in hardy kiwifruit (*Actinidia arguta* and its hybrid) during storage. *Sci. Hortic.* 130, 410.
- Lallu N., Searle A.N., Macrae E. A., (1989). An investigation of ripening and handling strategies for early season kiwifruit *Actinidia deliciosa* 'Hayward'. *J. Sci. Food Agr.* 47, 387 (1989).
- Liato V., Hammami R., Aïder M., (2017). Influence of electro-activated solutions of weak organic acid salts on microbial quality and overall appearance of blueberries during storage. *Food Microbiology*, vol 64, 56-64.
- Moura C., Masson M., Yamamoto C., (2005). Effect of osmotic dehydration in the apple (*Pyrus malus*) varieties Gala, Gold and Fuji. *Thermal Engineering*, vol 4, 46-49
- Mureșan E., Muste S., Borșa A., Vlaic R., Mureșan V., (2014). Evaluation 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.
- Mworia, E.G., Yoshikawa, T., Salikon, N., Oda, C., Asiche, W.O., Yokotani, N., Abe, D., Ushijima, K., Nakano, R., Kubo, Y., (2012). Low-temperature-modulated fruit ripening is independent of ethylene in 'Sanuki Gold' kiwifruit. *J. Exp. Bot.* 63 (2), 963–971 <https://doi.org/10.1093/jxb/err324>. PubMed.
- Namestnikov, A.F., Zagibailov, A.F., and Zver'kova, A.S., (1989). Tekhnologiya konservirovaniya tropicheskikh i subtropicheskikh fruktov i ovoshchei (*Technology of Preserving Tropical and Subtropical Fruits and Vegetables*), Odessa: Vysshaya Shkola.
- Oltenacu N., Lascăr E., (2015). Capacity of maintaining the apples quality, in fresh condition-case study. *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development* vol. 15, 331-335
- Saei A., Tustin D., Zamani Z., Talaie A., Hall A., (2011). Cropping effects on the loss of apple fruit firmness during storage: The relationship between texture retention and fruit dry matter concentration. *Scientia Horticulturae* 130, 256-265
- Skupień K., (2006). Chemical composition of selected cultivars of highbush blueberry fruit (*Vaccinium corymbosum* L.). *Folia Horticulturae* 18(2), 47-56
- Ticha A., Salejda A., Hyšpler R., Matejicek A., Paprstein F., Zadák Z., (2015). Sugar composition of apple cultivars and its relationship to sensory evaluation. *Nauka. Technologia. Jakość* 4 (101), 137-150
- Stănică, F.; Cepoiu, N. (1996). Actinidia - o nouă specie pomicolă pentru țara noastră (Kiwi – a new fruit specie for our country). *Rev. Horticultura* nr. 8, 22-25, București.
- Stonehouse W., C.S. Gammon, K.L. Beck, C.A. Conlon, P.R. Von Hurst, R. Kruger, (2013). Kiwifruit: our daily prescription for health. *Can. J. Physiol. Pharmacol.* 91, 442.
- Plekhanova, M.N., (1940) Aktinidiya, limonnik (*Actinidia and Schizandra*), Leningrad: Agropromizdat.
- Yoon K. Y., Woodams E. E., Hang Y.D., (2005). Relationship of acid phosphatase activity and Brix/acid ratio in apples. *Lebensm.-Wiss. u.-Technol.* 38, 181-183