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FRUIT SENSORIAL EVALUATION OF SOME KIWI HYBRID CULTIVARS (*ACTINIDIA* SP.)

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Abstract

The aim of this paper is to present preliminary data regarding the sensorial analysis and customers' perception on some hybrid kiwifruit, in different moments after harvesting. The plants were grown in the Experimental Field of Faculty of Horticulture, at the USAMV of Bucharest. The fruits were harvested starting in the beginning of October and finished at beginning of November. They were stored in two different conditions. At the time of consumption maturity, fruit analyses regarding flesh firmness, soluble solids (SSC) and vitamin C content, were performed for each genotype. Sensorial analyses were realized using a panel of consumers selected by age, gender and origin. The fruit size and shape, fruit pulp colour, taste and flavour were evaluated by awarding grades from 1 to 5. The results showed that the customer's preferences are influenced by gender, age and origin. The new kiwi hybrid selections were highly appreciated, most of the kiwifruit interspecific hybrid genotypes Actinidia deliciosa x Actinidia chinensis receiving higher scores than the single species varieties.

***Key words**: consumer preference, fruit characteristics, storage, questionnaire.*

INTRODUCTION

Actinidia (kiwifruit) is characterized by high content of biologically active compounds, including ascorbic acid (Plekhanova et al., 1940; Namestnikov et al., 1989).

According to Drummond (2013) kiwifruit is recognized as highly nutritious and low in calories with a potential to deliver a range of health benefits.

Over the past 20 years, there has been considerable interest in identifying new product opportunities for kiwifruit (Harker et al., 2007).

Harker (2007) mentions in a review study that consumer research was based on the identification of attributes that promote or inhibit kiwifruit consumption. Also Harker (2007) suggests that for kiwifruit sells increase it is necessary to take into account consumers' beliefs, attitudes and perceptions regarding this fruit and the impact of specific traits such as flavor, appearance and novelty on preferences and willingness.

Cangi (2011) points out that the maturity level, colors, sugar, solids, size and mechanical defects, firmness etc. are some of the important factors for kiwifruit marketing.

There are many studies focused on different varieties of *Actinidia* sp. concerning their health benefits, storage life and possibilities of maintaining and controlling postharvest kiwifruit ripening (Burdon et al., 2004; Stonehouse et al., 2013).

It was observed also that the postharvest preservation technologies are applied to reduce damage, prolong shelf life, and keep the nutritional quality of several fruits and vegetables (Liato et al., 2017).

In Romania the first kiwi orchards were planted in 1993 (Zuccherelli, 1994; Stănică & Cepoiu, 1996).

Harker (2007) suggests that in order to establish new flavor profiles for a wide range of kiwifruit genotypes and to map consumer preferences, different sensory panels can be used.

The studies illustrate that fruit breeding should target not only the elite fruit that are significantly more liked than the existing cultivars, but also special, unique fruit that create major new flavor niches (Harker et al., 2017).

Based on these considerations, the aim of this study is to evaluate the customer's preferences regarding the sensorial qualities of some Romanian kiwifruit hybrids, in different moments after harvesting.

According to Harker (2007) barriers to kiwifruit consumption often relate to the difficulty to determine when the fruit is ready to eat, and the need to use utensils to cut and scoop out the flesh to be able to eat it. Novelty can be either an advantage or a disadvantage depending on the openness of the consumers toward new foods (i.e., whether are conservatory or seek variety in their diet).

MATERIALS AND METHODS

Fruits sampling and preparation

In the Experimental Field at the Faculty of Horticulture - 26°6'0" East longitude and 44°25'60" North latitude, within the University of Agronomic Sciences and Veterinary Medicine of Bucharest an experimental field with kiwifruit hybrid genotypes, besides other varieties of *Actinidia deliciosa*, *A. chinensis* and *A. arguta*, was established.

For the study eight kiwifruit genotypes were used: R0P9, R0P10, R0P12, R1P9, R2P3, R2P6, R6P2 and R6P4. 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 starting in the beginning of October for *A. chinensis* selections (R0P9, R0P10), continued in 24th of October 2017 for some interspecific hybrids (R6P2, R2P6) and finished at beginning of November for other hybrids of *A. deliciosa* (R0P12, R1P9, R2P3, R6P4).

Harvesting moment was considered when the fruit flesh firmness was below 7 kgf/cm².

After picking, the fruits were stored in two different conditions: in cold storage at 3ºC and 95% humidity and in controlled atmosphere with 1.5% oxygen, 1-2°C and 95% relative humidity.

At the beginning of consumption maturity, fruit analyses regarding flesh firmness, soluble solids (SSC) and ascorbic acid content, were analysed for each hybrid.

Sensorial analyses were realized using different respondent panels selected by age, gender and origin. Fruit size and shape, fruit pulp color, taste and flavor were noticed with grades from 1 to 5.

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

Physico-chemical analysis

Fruit flesh firmness was determined by measuring the penetration force using an electronic penetrometer, equipped with a piston of 8 mm diameter. The results were expressed in kgf/cm² (Chen, 2015).

Soluble solids were determined from kiwifruit juice (Yoon, 2005; Saei, 2011; Mureşan, 2014; Oltenacu, 2015), with Krüss Refractometer DR301-95, the results being expressed in % Brix.

Ascorbic acid content of kiwifruit samples was determined with HPLC - Agilent Technologies 1200 Series equipment. A ZORBAX Eclipse XDB-C18 (4.6 x 50 mm, 1.8 µm) column with Rapid Resolution HT and a detector UV-DAD detection wavelength 220/30 nm, using reference as wavelength 400/100 nm. Mobile phases were A = 99% (ultrapure water with H_2SO_4 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 sulphuric acid to a pH of 2.1.

Then the tube was incubated for 45 minutes at 4°C under dark conditions. After this operation, 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 minutes post time, flow rate at 0.5 ml/minute at 30^{o}C in column compartment.

The samples were analysed in duplicate and were expressed in mg/100 g.

In order to perform the quantitative analysis of samples a calibration curve was obtained through injection of known concentration of standards (from 12.5 to 1000 µg/ml).

Sensorial analysis

Sensorial assessment was carried out in a sensorial testing laboratory by consumer panellists of different age, gender and origin.

Fruit quality was evaluated by appearance and taste (fruit size and shape, fruit pulp colour, taste and flavor) and for the results it was used a 1-5 rating scale.

The tasting panel was formed by 168 respondents with ages from 14 to over 60 years old, both males and females, from rural and urban area.

In order to perform a representative study, eight of the questionnaires were rejected because the respondents skipped one or more questions.

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 were harvested when the fruit flesh firmness was less than 7 kgf/cm² (Figure 1). The initial physical and biochemical analysis, after harvesting time (average fruit weight, fruit flesh firmness, soluble solids content) are presented in Table 1. The size of green kiwifruits ranged from small (44.83 g at R6P4) to large (102.18 g at R1P9), while the yellowish fruit of the interspecific hybrid (R2P6 and R6P2) was rather small in size with only 11.22 g or 12.33 g (Table 1). For *A. chinensis* genotypes were registered 31.82 g for R0P9 and 37.03 g for R0P10.

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 analyses regarding soluble solids content (SSC), firmness and ascorbic acid were performed for each genotype (Table 2).

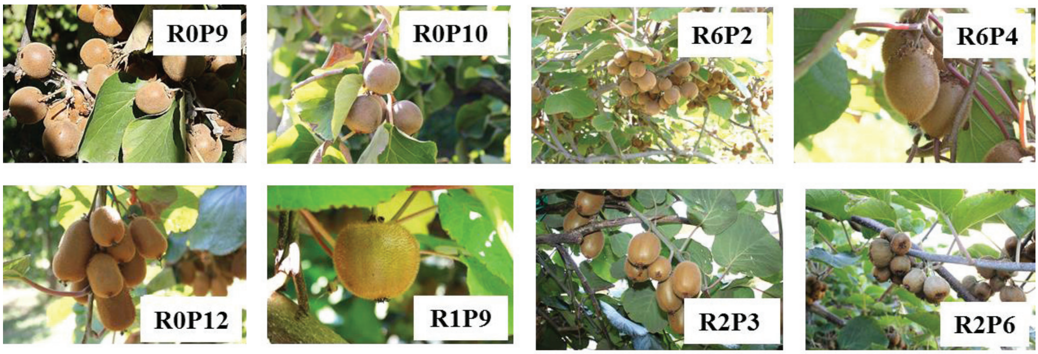

Figure 1. Studied kiwifruits hybrids photographed before harvesting time

Table 1. Physical and biochemical characteristics of kiwifruit genotypes before storage

Genotype	Time of harvesting	Average fruit weight (g)	Firmness (kg/cm^2)	Soluble solids content (% Brix)
R0P9	04.10.2017	31.82	6.05	10.16
R0P10	04.10.2017	37.03	6.45	10.16
R6P2	24.10.2017	12.33	6.08	11.34
R6P4	24.10.2017	44.83	7.10	12.65
R0P12	06.11.2017	46.21	2.28	11.33
R1P9	06.11.2017	102.18	1.32	13.54
R2P3	06.11.2017	88.66	2.27	10.96
R2P6	06.11.2017	11.22	0.99	15.34

Table 2. Physical and biochemical characteristics of kiwifruit genotypes at the beginning of ripening

Genotype	Time of maturity consumption	Firmness (kg/cm^2)	Soluble solids content (% Brix)	Ascorbic acid content (mg/100 g)
R0P9	30.01.2018	0.12	15.5	498.05 ±18.50
R0P10	15.01.2018	0.20	10.9	536.30 ± 4.42
R6P2	15.01.2018	0.45	14.2	100.23 ± 0.10
R6P4	14.11.2017	0.58	14.8	105.83 ± 1.78
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

For all genotypes throughout storage, a noticeable increase in soluble solids content can be observed (Figure 2). The fruits flesh firmness reduced constantly after harvesting (Figure 3).

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/cm^2.

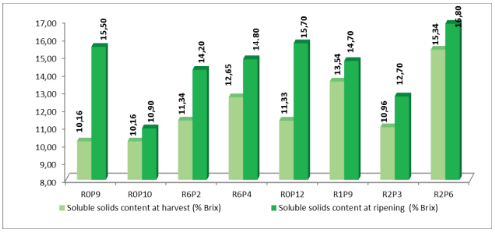

Figure 2. Evolution of soluble solids content (% Brix) for studied kiwifruit genotypes

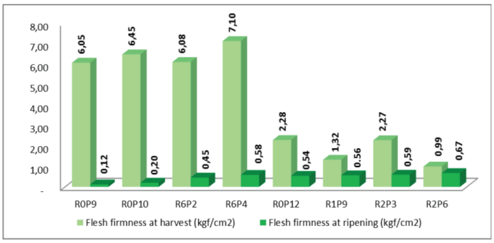

Figure 3. Evolution of fruit flesh firmness (kgf/cm^2) for studied kiwifruit genotypes

The fruit ascorbic acid content varies between the studied genotypes of *A. chinensis* from 498.05±18.50 mg/100 g (R0P9) to 536.30 ± 4.42 mg/100 g (R0P10) (Figure 4).

The measured values were higher than those reported in previous studies (Huang et. al., 1983; Kolbasina, 1986; Ferguson et al., 1988; Ferguson et al., 1992; Nishiyama, 2007).

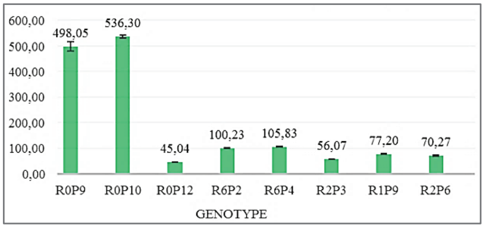

Figure 4. Ascorbic acid content (mg/100 g) at the beginning of ripening stage for studied genotypes

The ascorbic acid content of the interspecific hybrids genotypes R6P2 (100.23 ± 0.104 mg/100 g) and R6P4 (105.83 ± 1.783 mg/100 g) is also considered high.

For the hybrids genotypes of *A. deliciosa* the determined ascorbic acid content varied from 45.04 ± 0.13 mg/100 g (R0P12) to 77.20 ± 0.85 mg/100 g (R1P9).

Between the obtained values and the values reported in previous studies there were small differences (Huang et al., 1983; Visser et al., 1983; Nishiyama, 2004; Nishiyama et al., 2004; Nishiyama, 2007).

Kiwifruits quality was evaluated for appearance and taste by different consumers in different ripening stages.

For a better understanding of respondents' opinion and preferences on the Table 3 is presented their socio-demographic profile. The interviewed respondents were from 14 to more than 60 years old. 47% of them were women and 53% men. In 69.3% of the cases people were from the urban area and only 30.7% of them from the rural area.

Table 3. The socio-demographic profile of respondents

Criteria	Range	%
Age group (years)	<18	5.8
	18-24	37.4
	25-34	26.3
	35-44	14.2
	45-54	11.6
	55-64	4.7
Gender	female	47.0
	male	53.0
Origin area	urban	69.3
	rural	30.7

Sensorial analyses were organized for certain genotypes, monthly and the results are presented in the following figures (5-9) for each criterion: fruit size and shape, fruit flesh colour, taste and flavor.

In November, three fruit tastings were organized for R6P4, R2P3 and R2P6 genotypes. In January two fruit tastings were organized: on 15th for R0P10, R6P2, R2P3 and R2P6 genotypes and on 30th for R0P9, R0P10 and R2P3 genotypes.

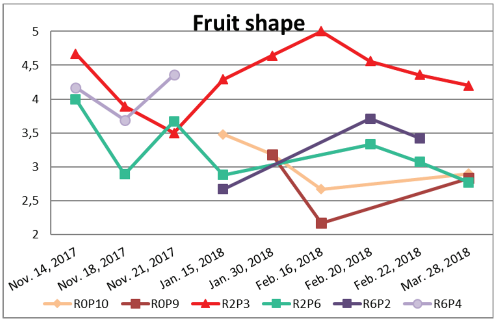

Figure 5. Evolution of customers' perception on fruit shape

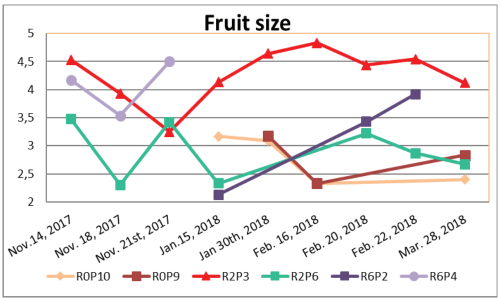

Figure 6. Evolution of customers' perception on fruit size

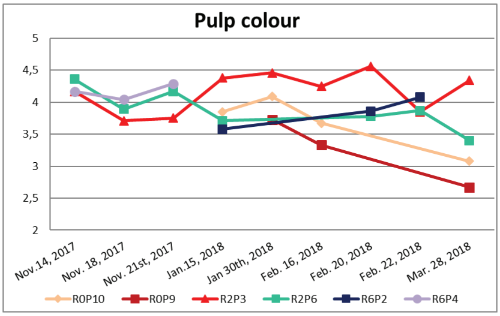

Figure 7. Evolution of customers' perception on fruit flesh colour

In February tree sensorial tastings were organized: on 16th for R0P9, R0P10 and R2P3 genotypes; on 20th and 22nd for R6P2, R2P3, R2P6 genotypes.

In March 28th the sensorial tasting was organized for R0P9, R0P10, R0P12, R1P9, R2P3 and R2P6 genotypes.

According to the fruit ripening phase, consumers have appreciated the different genotypes and the total score awarded for each is presented in Table 4.

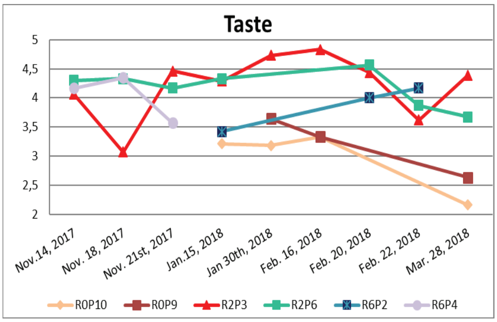

Figure 8. Evolution of customers' perception on fruit taste

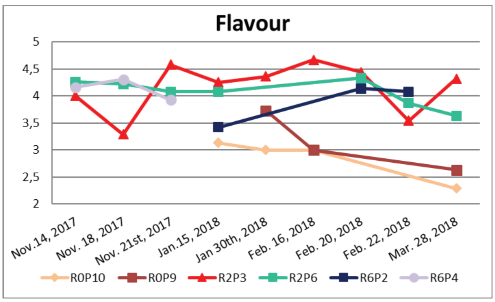

Figure 9. Evolution of customers' perception on fruit flavor

Table 4. Customers' perception on some kiwifruit hybrid genotypes in different ripening stages

Genotype	Date of sensorial analysis	Total score
R0P9	January 30th	**17.45**
	February 16th	14.17
	March 28th	13.63
R0P10	January 15th	**16.83**
	January 30th	16.55
	February 16th	15.00
	March 28th	12.82
R6P2	January 15th	15.21
	February 20th	19.14
	February 22nd	**19.67**
R6P4	November 14th	**20.97**
	November 18th	19.92
	November 21st	19.50
R0P12	March 28th	**18.21**
R1P9	March 28th	**19.34**
R2P3	November 14th	21.42
	November 18th	17.89
	November 21st	20.64
	January 15th	21.33
	January 30th	22.82
	February 16th	**23.58**
	February 20th	22.44
	February 22nd	19.92
	March 28th	21.37
R2P6	November 14th	**20.41**
	November 18th	17.63
	November 21st	19.54
	January 15th	17.33
	February 20th	19.22
	February 22nd	17.54
	March 28th	16.13

Genotypes rated with the highest score were R2P3 (23.583) - in January 30th, followed by R6P4 (20.965) and R2P6 (20.407) – in November 14th.

According to Table 2, R2P3, R6P4 and R2P6 obtained also good values regarding soluble solids content, at the beginning of ripening. That for the results of the analyses confirm the customers' preferences.

Genotype rated with the highest score for all evaluation criteria (fruit shape and size, pulp colour, taste, flavor) was R2P3. The total mean value was 21.62 (Table 5).

In Table 5 are presented the average evaluation values for each criterion and for each genotype.

Table 5. The average value of the evaluation for each criterion for each genotype

Genotype	Fruit shape 1-5	Fruit size 1-5	Pulp color 1-5	Taste 1-5	Flavor 1-5	Total 5-25
R0P9	2.73	2.78	3.24	3.20	3.13	15.08
R0P10	3.06	2.75	3.63	2.97	2.85	15.30
R6P2	3.26	3.16	3.84	3.86	3.88	18.01
R6P4	3.90	3.71	4.16	4.19	4.17	20.13
R0P12	3.37	3.21	4.03	3.79	3.82	18.21
R1P9	4.29	4.24	3.93	3.56	3.32	19.34
R2P3	**4.49**	**4.45**	**4.28**	**4.22**	**4.18**	**21.62**
R2P6	3.20	2.87	3.82	4.22	4.14	18.26

For R0P9 genotype total mean value was 15.084. The most appreciated criterion was the colour of the fruit pulp (Figure 10 - A).

The total mean value for R0P10 genotype was 15.30. The most appreciated criterion was the colour of the pulp (Figure 10 - B).

For R6P2 genotype total mean value was 18.01.

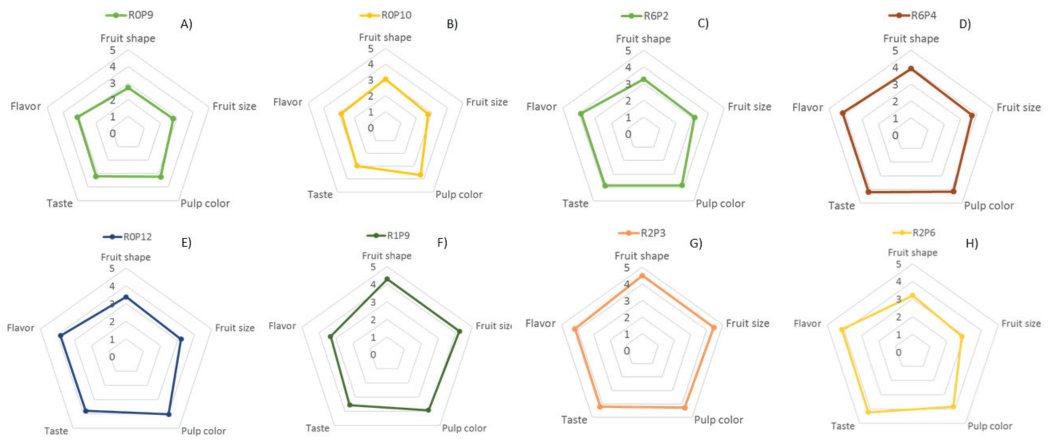

Figure 10. Kiwi fruits sensorial analysis - Distribution of characters for studied hybrids

The most appreciated criterion was the flavour (Figure 10 - C). For R6P4 genotype total mean value was 20.13.

The most appreciated criterion was the taste (Figure 10 - D). The content of SS, at the beginning of ripening (14.8 % Brix - Table 2) confirm the appreciation of customers for taste.

The total mean value for R0P12 genotype was 18.21. The most appreciated criterion was the colour of the pulp (Figure 10 - E).

For R1P9 genotype total mean value was 19.342. The most appreciated criterion was the fruit shape (Figure 10 - F).

For R2P3 genotype the total mean value was 21.62. The most appreciated criterion was the fruit shape (Figure 10 - G).

For R2P6 genotype total mean value was 18.26. The most appreciated criterion was the taste (Figure 10 - H). Also for this hybrid, the SS at the beginning of ripening was very high – 16.8 % Brix.

CONCLUSIONS

Genotype rated with the highest score for all evaluation criterias was R2P3 with a total mean value of 21.62.

The genotypes that were most appreciated for shape of the fruit were R1P9, with the total mean value of 19.34 and R2P3, with the total mean value of 21.62.

Average fruit weight (g) for R1P9 measures 102.18 g and the fruits of this hybrid have a nice spherical shape. Also for R2P3 average fruit weight (g) recorded a high value – 88.66 grams.

The genotype that were most appreciated for color of the pulp were – R0P9 (15.08 - total mean value), R0P10 (15.30) and R0P12 (18.210).

For taste, the genotype that were most appreciated were R6P4 (20.13) and R2P6 (18.26).

For flavor, the genotype that was most appreciated was R6P2 with the total mean value 18.01.

The highest amount of ascorbic acid content was determined for R0P10 - 536.30 ± 4.42 mg/100 g and for R0P9 - 498.05 ±18.50 mg/100 g (*A. chinensis* genotypes).

In the case of soluble solids content it was observed that R2P6, R0P9 and R0P12 have the higher content, 16.8, 15.5 and 15.7% Brix, respectively.

Following the obtained results, we can specify that kiwifruit hybrid genotypes received good appreciation from consumers and best of the tested hybrid genotypes (R2P3, R6P4 and R1P9) will be proposed to be propagated and introduced in the production test phase.

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