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Pomological Traits of the Most Significant Cultivars of Kiwifruit (*Actinidia chinensis* Pl.) in the Conditions of Bar

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Abstract: The paper presents the results of a two-year study on the most important morphometric and technological properties of the fruit of four kiwifruit cultivars (Hayward, Bruno, Monty and Abbot) in the conditions of the Montenegrin coast.

It has been established that the cultivar Hayward is characterized by extremely large fruits as opposed to the other cultivars being considerably inferior in the trait. The cultivar Monty produces very small fruits, whereas the average fruit weights of the Abbot and Bruno cultivars are between the values recorded for the above mentioned cultivars.

The lowest dry matter content has been recorded in the Monty cultivar and the highest one in the variety Bruno.

Key words: *Actinidia*, fruit, morphometric properties, technological properties, yield..

Introduction

As a perennial trailer from China spread in the valley of Yangtze, kiwifruit originated from China (Li Hui Lin, 1952, cit. according to Milosevic, 1979) It was transferred to New Zealand in 1906 by Jammes Mc Gregor. Kiwifruit is presently being grown on the area of 78.050 ha, its total production of 672,050 t. According to Retamales and Defilippi, 1999 (cit. by Milosevic and

Petrovic 2001), kiwifruit is mostly grown in Italy (19,500 ha), New Zealand (10,700 ha) Chile (7,500 ha), Japan (6,300 ha) and France (5,500 ha).

Kiwifruit growing doesn't have a long tradition. The first plantings were established in 1977 in the surroundings of Bar and on the Monte Negro's coast. The areas under this fruit have enlarged for past ten years, with about 50 ha being under this species.

Kiwifruit fruits are used fresh and processed as fruit salad, jelly, syrup, juices and others. In addition, its fruits are highly rich in vitamin C (200-300 mg/100 g fruit), mineral matters, carbohydrates and proteins. The fruits can be kept frozen till May in the northern hemisphere, thus, their distribution on the market is possible for a longer period. Kiwifruit also calls for no pest and disease control since none of it has appeared in the kiwifruit growing areas. If we take its high price on the market into account, the economicity and significance of its growing is doubtless.

The objective of the paper was to establish the most significant pomological characteristics of the leading kiwifruit cultivars and to determine their cropping, i.e. the yield per tree which would make it possible to choose cultivars for breeding and selection more properly in the future.

Similar problems were studied and results published, particularly of Youssef and Bergamini (1979), Monastra et al., (1983), sale (1985), Popovic (1986), Plamenac and Radulovic (1987), Bazzocchi (1988) and others.

Materials nad Method

The cultivars of kiwifruit were studied from 1997-1998 in the experimental kiwi growing planting in Bar established at the altitude of 5 m.

The distance of planting was 4 x 4m, with pergola growing form (drawing 1)

The study comprised 20 trees with block system arranged.

At the beginning of the experiment, the trees were 6 years old.

Material—The leading (Hayward) and the accompanying inland cultivars (Monty, Bruno and Abbott) were used as the experimental material, as well as the the cultivar Tomuri used as pollinator (draw. 2-5). All the cultivars were grafted to seedlings of kiwifruit (*A.chinensis* Pl.).

Over the studies, common care of the planting was taken (pruning to ripeless and ripe), soil tillage, fertilization and irrigation, without disease and pest control as being unnecessary

Methods – the caharacters of

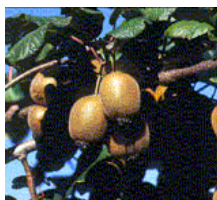


Drawing 1 Experimental producing orchard

fruits were analysed by determining morpho-metric, biophysical and chemical properties.

Of the morphometric properties of fruits, the following was surveyed:

- length (mm),
- width (mm),
- thickness (mm), and
- petiole length (mm).



Draw 2. Hayward



Draw 3. Bruno



Draw 4. Monty



Draw 5. Abbott

The measurement was made using vernier callipers, brand MEBA, with values expressed in mm with the precision of 1/10 mm.

Of the biophysical fruit characters, the following was surveyed:

- mass (g);
- skin (g);
- petiole mass (g);
- seed mass (g).

The assay comprised 25 fruits of each cultivar. Fruit mass was determined on the electronic scales 'TEHNICA' with the accuracy 1/10 g and values expressed in g.

Of the chemical fruit properties, the following was analysed:

- water content (%);
- dry matter content (%);
- total acid content (%), and
- ascorbic acid content (mg/100 g fruit).

Water content was determined drying up the fruits in the dryer at 105°C, and the total dry matter content drying fruits at the temperature of 55°C until the constant mass was reached.

The content of total acids was determined titrimetrically, calculated as citric.

Ascorbic acid (vitamin C) was determined after the method of Feldheima (1960). The method implies oxidation of ascorbic acid with 2,6 dichlorophenol-indolphenol. The reading on the standard curve was made of the ascorbic acid content. 25 fruits of each cultivar were used as a sample.

The cropping of the cultivars was analysed per number of fruits per tree and their average mass expressed in kg per tree.

The obtained data were processed through the analysis of variance (F test), with the level of significance of the differences found by LSD test.

Environmental conditions

The area of Bar, where the cultivars were studied, is a typical mediterranean area of the mediterranean climate representing subtropic areas of Monte Negro with well thriving subtropic cultivars.

Meteorological conditions. The data obtained over many years (1951-1990) gave the mean annual air temperature of 15,6°C for Bar. The absolute minimal temperature for the same period amounted to 8,2°C (15 January 1985,) and the absolute maximal one to 36,8°C (20 July 1987) as cited by Fustic and Đjuretic (2000).

As reported by the same authors, the average annual rainfalls for the period (1951-1990) amounted to 1,411 mm/m². For seven months of the vegetation (April-October), the average precipitations amounted to 594 mm/m² or the monthly average for that period of 84,85 mm/m². The lowest precipitations were registered in summer (144 mm/m²), and the highest ones in winter (488 mm/m².) The most of rainfalls fell in October (433mm/m²) and the least of them did in July (127 mm/m²). So unevenly distributed precipitations imposed irrigation over the periods critical for kiwifruit, when the intensive biological-physiological processes would occur in it.

The average relative wettness of air ranged from 64% (February) to 74% (May).

Abundance of light features this region, 2,499 hours per year and the heat of 5,700 degrees above 10,0°C, for the period from 8 March to 5 December.

The winds featuring this area blow from the north-east and east, of the average force 1,6 wind (Beaufort number). The winds are very strong, cold and dry and, as such, harmful to kiwifruit for drying leaves, breaking seedlings and shaking off the fruits, leading to decline in yield. Detrimental effect of winds can be alleviated by setting up windproof belts made of coniferous fast growing trees.

In general, the climate has mild winter, early and warm spring, long and dry summer with warm and long autumn.

Soil conditions. The alluvial-deluvial soil type of the extremely uniform mechanical composition prevails to the area of Bar. The soil is weakly carbonate and weakly humus (2%), of bare porosity, insufficiently water permeable with medium air capacity, due to which, hydro-melioration measures must precede establishing of a planting..

Plantation type of a planting exists on the alluvial drift of a lighter mechanical composition, good air porosity and medium water capacity. The soil is mildly acid (pH-5.5-6.0), of medium humus supply (3,5%) and P (8,00mg/100 g air dry matter) and good K supply (28,05 mg/100g air dry soil).

Results and Discussion

The results of studying morphometric, biophysical and chemical properties of the fruits and the cropping of the kiwifruit cultivars are presented in the tables 1-4.

Morphometrical features of the fruits

Fruit length – is a biological property, largely depending on the cultivar genotype, agro and pomotechnical measures, and particularly on how much fruits

have loaded the tree and on the fruit number per unit of the leaf assimilation surface.

Tab.1. Morphometrical features of kiwifruit fruits

Cultivars	Fruit length (mm)	Fruit width (mm)	Fruit thicknes (mm)	Petiole length (mm)
Monty	53.50	38.00	36.30	29.90
Abbott	67.20	39.10	37.30	40.70
Bruno	77.30	43.50	41.40	51.60
Hayward	68.60	55.85	54.00	53.70
Average	66.60	44.12	42.25	43.97
LSD (5%)	0.429	0.429	0.466	0.519
LSD (1%)	0.560	0.560	0.576	0.698

The study results in the tab.1 show that the differences among the cultivars in fruit length are statistically highly significant. The cultivar Brubo was found to have the longest (77,30mm) whereas Monty had the shortest (53,50mm) fruits. The fruit mass averaged 66,60mm. The differences in fruit length can be attributed to the cultivar genotype.

Fruit width - the analysis of variance and LSD test have shown the differences in the fruit width to be statistically highly significant as can be seen from the data given in the tab.1

The cultivar Monty had the lowest (38,00mm) and Hayward the greatest fruit width, which averaged 44,12 mm for all the cultivars.

Fruit thickness - the obtained data suggest statistically highly significant differences in the average fruit thickness, with Hayward (54,00 mm) ranking first, Bruno (43,00mm) and Abbott (39,10mm) legging visibly behind and Monty being the last (38,00mm). The differences concerned are attributed to the cultivar genotype.

Petiole length - presents an outstanding morphometric feature. Statistically, the differences found in this regard were prominent among the cultivars. A great difference in the average petiole length existed between Hayward (53,70mm) and Monty (29,90mm), with Bruno (51,60mm) and Abbott (40,70mm) being within the ranges cited.

Biophysical fruit traits - Study results implying fruit mass, skin mass, seed mass and fruit petiole are presented in tab.2.

Tab. 2. Biophysical properties of the kiwifruit fruit

Cultivars	Fruit mass (g)	Skin mass (g)	Seed mass (g)	Petiole mass (g)
Monty	46.30	0.80	0.60	0.40
Abbott	67.10	1.00	0.70	0.50
Bruno	80.20	1.35	1.00	0.80
Hayward	107.00	1.61	1.20	0.70
Average	75.15	1.19	0.87	0.60
LSD (5%)	1.054	0.140	0.090	0.032
LSD (1%)	1.389	0.160	0.012	0.042

Fruit mass – Comparing fruit mass of Hayward (107,00 g) to others (Bruno (80,20 g) and Abbott (67,10 g), it was obviously larger and the differences among the cultivars were statistically fully justified.

The cultivar is featured by a considerably low fruit mass of only 46,30 g. The fruit mass averaged 75,15 g for all the cultivars.

Similar data on the average fruit mass in kiwifruit were cited by Monastra et al., (1983), Sale (1985), Popovic (1986) and Plamenic and Radulovic (1987).

Skin fruit mass – is averagely of the variable character, ranging from 0,80 g in Monty to 1,61 g in Hayward. The cultivar Abbott had the average mass of skin of 1,00 g and Bruno 1,35 g. Similar to the fruit mass, statistically highly significant discrepancies existed between Hayward and other cultivars in their skin mass, averaging 1,19 g for all the cultivars.

These results are corroborated by those obtained by Plamenac and Radulovic (1987) in similar studies.

Seed mass – in kiwifruit and other fruits depends on the fruit length and width, and is positively correlated with fertility level. Seed mass is a stable feature of each fruit cultivar reliably determining and classifying the cultivars. As presented in tab.2., seed mass for all the cultivars averaged 0,87 g. Hayward had the highest seed mass (1.20 g) which was statistically highly significantly higher in relation to the other cultivars, especially that of Monty averaging 0,60 g.

Petiole mass – based on the data in tab.2, petiole mass in all the cultivars amounted to 0,60 g. The highest average petiole mass was found in Bruno of 0,80 g, somewhat lower in Hayward of 0,70 g, and the lowest in Monty of 0,40 g.

The analysis of variance and LSD test pointed at statistically significantly high differences attributed to the genetic base of the cultivar.

Technological properties of the fruit

As presented in the tab.3., water content, dry matter content, of the total acids and ascorbic acid varied in all the cultivars.

The fruits of kiwifruit averagely had 85.45% water, with its highest content found in the fruits of Monty (86,30%) and the lowest one in those of Bruno (84,50%).

Bearing in mind that water and dry matter content are inversely correlated, that the lowest dry matter content was in Monty (13,70%) and the highest one in Bruno (15,50%) was crystal clear.

The analysis of variance and LSD test indicated water and dry matter content in fruits to be statistically highly differing among the cultivars.

Tab3. Technological properties of the kiwifruit fruit

Cultivar	Water (%)	Dry matter (%)	Total acids (%)	Ascorbic acid (mg/100g fruit)
Monty	86,30	13,70	1,45	173,34
Abbott	85,60	14,40	1,34	149,77
Bruno	84,50	15,50	1,51	213,94

Hayward	85,40	14,60	1,41	178,24
Average	85,45	14,55	1,42	178,82
LSD (5%)	0,161	0,155	0,019	5,412
LSD (1%)	0,212	0,204	0,025	7,130

As can be seen in the tab.3., the content of the total acids in Bruno (1,51%) was statistically highly significantly higher compared to Abbott (1,34%) , whereas those in Monty (1,45%) and Hayward(1,41%) had no marked differences.

The cultivar Bruno with 213,94 mg/100 g fruit excelled in ascorbic acid level (vitamin C) in its fruits relating to other cultivars, succeeded by Hayward (178,82 mg/100g) Monty (173,34 mg/100g fruit) and Abbott with its visibly lower level of only 149,77 mg/100 g fruit. The differences found were statistically highly justified.

The current results coincided with those of Yossef and Bergamini (1979) for the total acids and ascorbic acid content.

Cropping of kiwifruit cultivars

Biological potential of the fruit cropping, including kiwifruit, stems from genetic base of a cultivar, environmental conditions for cultivation and from the use of agro-pomological measures. The knowledge about cropping is of outstanding importance, particularly when choosing the cultivar for commercial intensive growing.

Tab.4. The average yield in the kiwifruit cultivars (kg/tree)

Cultivars				
Monty	Abbott	Bruno	Hayward	Average
50.80	39.70	36.00	36.50	40.75
LSD (5%)		1.357		
LSD (1%)		1.784		

Based on the results of the tab.4 ., the yield for all the cultivars averaged 40,75 kg/tree. The lowest average yield pertained to Bruno with 36,00 kg/tree, somewhat higher to Hayward (36,50 kg/tree) and Abbott (39,70 kg/tree), and particularly high to Monty of up 50,80 kg/tree being statistically highly significantly higher compared to the previously mentioned kiwifruit cultivars.

Conclusion

Based on study results of the morphometric, biophysical and technological features of the fruit and cropping per tree in the most significant kiwifruit cultivars grown in the vicinity of Bar, the following may be concluded:

- Environmental and soil conditions of the Monte Negro's subtropic zone entirely meet the kiwifruit growing requirements commercially.
- A markedly long fruit characterised the cultivar Bruno, with the other ones much lagging behind it, especially Monty with its lowest value established.

- The cultivar Hayward had the widest fruit. The cultivar Bruno didn't markedly leg behind, whereas Abbott and Monty had considerably lower values. Fruit thickness was positively correlated with its width, with the highest values found in Hayward and the lowest ones in Monty. Hayward indicated nearly twice as high values for the character under way compared to the cultivar Monty.
- The cultivar Hayward is characterised by considerably large fruits, whereas the other cultivars were largely legging behind this one. Monty had extremely small fruits, whereas the fruits of Abbott and Bruno had the average fruit mass between the cultivars mentioned.
- The average mass of skin and seeds was positively correlated with the average fruit mass. Their highest values were established in the cultivar Hayward, and the lowest ones in Monty. The highest fruit petiole mass was found in the cultivar Bruno, whereas twice as less value was found in Monty. The Hayward cultivar ranks immediately after Bruno.
- The lowest dry matter content was registered in Monty, and the highest one in Bruno. The lowest water level was registered in the fruit of Bruno, and the highest one in Monty.
- The lowest total acid content was reported in Abbott, and the highest one in Bruno and *vice versa* in terms of ascorbic acid content.
- The cultivar Monty indicated the best and Bruno the worst cropping per tree.

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**POMOLOŠKE OSOBINE NAJZNAČAJNIJIH SORTI AKTINIDIJE
(*Actinidia chinensis* Pl.) U USLOVIMA BARA**

- originalni naučni rad -

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Rezime

U radu su prikazani dvogodišnji rezultati koji se odnose na najznačajnije morfo-metrijske, tehnološke i proizvodne osobine ploda četiri sorte aktinidije (Hayward, Bruno, Monty i Abbot) u uslovima crnogorskog primorja.

Utvrđeno je da se sorta Hayward odlikuje izuzetno krupnim plodovima, dok ostale sorte znatno zaostaju. Veoma sitnim plodovima odlikuje se sorta Monty, dok sorte Abbott i Bruno imaju prosečnu masu plodova između vrednosti gore pomenutih sorti.

Najmanji sadržaj suve materije registrovan je u sorte Monty, a najveći u sorte Bruno.