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Comparative Evaluation of Some Physiological and Morphological Characteristics of Two Genotypes of Golden kiwifruit (*Actinidia chinensis*)

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Introduction

Kiwi plant belongs to *Actinidia* genus and *Actinidiaceae* family, has more than 70 species and 100 varieties. From the point of view of histology, there are 3 types of tissue in kiwifruit, from the outside to the inside, respectively, including outer pericarp, inner pericarp and fruit core. The skin of the fruit has lenticels and is covered with trichomes in the most species. The amount of soluble solids content is one of the key indicators for determining the time of fruit harvesting (Afshar Mohammadian & Fallah. 2016). Kiwifruit has a high amount of organic acids, which include 1-3 % of the fresh weight of the fruit. One of the most important qualitative characteristics of kiwifruit is the taste index (Nardozza et al. 2011). Accordingly, the sweet taste of the fruit is one of the most important qualitative characteristics of kiwifruit. Kiwifruit with dry matter of more than 16 % is more acceptable to consumers than kiwifruit with dry matter less than this amount. The fruit firmness is an important indicator to determine the storage potential of kiwifruit (Feng et al. 2011). Meanwhile, vitamin C is the most distinctive nutritional characteristic of kiwifruit. Kiwifruit contains bioactive compounds that are very important for human health including phenolic compounds. The antioxidants of kiwifruits are strongly influenced by the concentration of total phenol and ascorbic acid. The aim of this research was to compare some physiological and anatomical indicators related to the nutritional value of kiwifruit in two golden kiwifruit genotypes (Y_1 and Y_2).

Material and Methods

The fruits of two golden kiwifruit genotypes (Y_2) and (Y_1) were harvested in October 2021 from the research garden of the Faculty of Agricultural Sciences, University of Guilan, located in Rasht city, and the experiments were carried out in 3 replicates. The length, width and diameter of the internal tissues of the fruits were manually measured using a ruler. The density of lenticels and the types of the hairs on the surface of the fruit skin per unit area (mm^2) examined using an optical microscope with magnification of 4 and 10×. The soluble solid content (SSC) of the fruits were measured using a digital refractometer (EUROMEX RD). Determination of the amount of titrable acid of the fruits was carried out using the method of Zhang et al. (2022) based on the amount of the dominant acid of the fruits (citric acid). The firmness of the fruit tissue was measured by a penetrometer model GY-3. Determination of the dry matter percentage of the fruits was measured according to the method of Lee (1981). The amount of vitamin C was measured by titration with dichlorophenol and indophenol and calculated in milligrams per hundred grams of fresh weight of the fruit tissue. Folin Cicalcho method was used to determine the amount of total phenol of the fruits. For this purpose, after preparing the ethanolic extract from the fruits, the amount of total phenol was read at a wavelength of 720 nm in a spectrophotometer (Camspec-M501 Single Beam UV/Vis Spectrophotometer) and gallic acid was used as a standard for total phenol measurement. The assessment of the antioxidant capacity of kiwifruit extract was performed using the free neutralizing property of 1 and 1 diphenyl 2 p-crylhydrazyl (DPPH). For this purpose, the amount of neutralized DPPH radical was calculated using a spectrophotometer at a wavelength of 515 nm, and the percentage of antioxidant capacity was calculated.

The results and data were analyzed by SPSS statistical software and two-sided T-test, and the significance comparison and standard error were checked at $P<0.05$ level.

Result and Discussion

The results showed that the mean length and the mean width of the fruits in Y_2 genotype were significantly higher than Y_1 genotype, while the evaluation of the fruit shape did not show a significant difference. According to the research, larger fruits are more acceptable in the market and accordingly Y_2 genotype will be more marketable.

In the transverse and longitudinal section of the fruits of both studied genotypes, outer and inner pericarp tissues and fruit core were observed. Outer pericarp diameter in Y_2 genotype, fruit core diameter and the ratio of total pericarp diameter to fruit core diameter were significantly higher in Y_1 genotype compared with Y_1 genotype, although no significant difference was found in inner pericarp diameter in between. Considering that the amount of the fruit flesh was higher in Y_2 genotype, the marketability of this genotype will be better compared with Y_1 genotype.

Two types of long and short trichomes were observed on the surface of the fruit skin of both genotypes. The density of short trichomes and the density of single long trichomes per $1mm^2$ were higher in Y_2 genotype than Y_1. The total ratio of long trichomes to short trichomes and the total ratio of multi-branched trichomes to single trichomes in Y_1 genotype were higher than this ratio in Y_2 genotype. In both genotypes, the lenticels were light brown and oval shape. The presence of the branched trichomes can decrease the amount of the water loss of the fruits. Therefore, it is expected that Y_1 has more ability to preserve fresh weight of the fruits compared with Y_2 genotype.

The amount of the soluble solid content in Y_1 genotype was higher than Y_2 (10.95 vs. 10.40, respectively). Researchers have shown that fruits which are harvested with a higher SSC have a greater storage capacity (Afshar Mohammadian & Fallah. 2016) and this shows the importance of paying attention to the percentage of SSC at the fruit harvesting time.

The predominant fruit acid percentage was similarly low in both examined genotypes, so that this amount was 0.39 % and 0.51 % for Y_1 and Y_2, respectively. The amount of organic acids plays a significant role in the taste of kiwifruit (Ahn et al., 2020). Also, the taste index in Y_1 (30.72) was significantly higher than this ratio in Y_2 (21). Therefore, the Y_1 genotype will have a sweeter taste.

The percentage of fruit dry matter in both genotypes was higher than the maximum standard declared for the percentage of dry matter of kiwifruit (20.61 and 20.76, respectively in Y_1 and Y_2) and as a result the taste of the fruit of these two genotypes at the time of consumption will be more desirable. The dry matter percentage of kiwifruit has a positive effect on the consumer's willingness to buy the fruits (Black et al. 2011).

In both genotypes, the fruit firmness was high (7.42 and 7.76 kg/cm^2 in Y_1 and Y_2, respectively) and no significant difference was seen in between. Shiri et al. (2016) reported the mean fruit firmness of Hayward cultivar 7.89. The softening of the fruit flesh during storage could be due to the degradation of pectin of the intercellular membrane (Kaur et al. 2013).

The amount of vitamin C in Y_2 was higher than that in Y_1 (35.06 mg.100-1FW vs. 28.51 mg.100-1FW), although this difference was not significant. Lee et al. (2018) reported the amount of vitamin C in Hort16A and Hayward cultivars 66.5 and 57.3 mg.100-1FW, respectively. This natural variation of vitamin C levels in fruits, including kiwifruit, is due to several factors including growing conditions, using fertilizers, physiological maturity at harvest time, and storage conditions (Richardson et al, 2018).

Total phenol content was almost similar in both genotypes (22.42 and 24.98 mg GA.100-1FW in Y_1 and Y_2, respectively), so that the differences were not significant. In a research conducted by Ma et al. (2017), the amount of total phenol was reported between 58.45 and 152 mg of GA.100-1FW in the 11 studied kiwifruit cultivars. The total phenolic content is affected by various factors, including the type of species and cultivar, different components of the fruit and the time of harvesting (Tavarini et al., 2008; Zhu et al., 2021).

The percentage of antioxidant capacity in Y_2 was higher than Y_1 (23.15 % vs. 13.89 %, respectively), although this difference was not significant. Farzam et al. (2018) reported the antioxidant capacity of Hayward variety 52.56 %. In the present study, the percentage of antioxidant capacity in Y_2 (23.15 %) was higher than Y_1, because the content of total phenol and vitamin C was also higher in this genotype.

Conclusions

In this research, it was found that in terms of fruit size characteristics, the ratio of edible flesh of the fruit to its core, the density of individual short and long trichomes, as well as the percentage of dry matter, fruit firmness, vitamin C content, total phenol content and antioxidant capacity in Y_2 genotype were higher than Y_1. Therefore, Y_2 genotype has a better commercialization field compared with Y_1 genotype. Considering the increasing of consumers' willingness to consume new genotypes of kiwifruit, it is suggested to conduct more research to obtain extensive information about new genotypes of kiwifruit.

Keywords: Kiwifruit, Trichome, Nutritional value, Vitamin C.

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Declaration of conflict of interest

The authors declare that they have no conflicts of interest.