

FRUIT QUALITY ANALYSIS OF KIWIFRUIT CULTIVARS CULTIVATED IN EASTERN MID-HILLS OF NEPAL

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ABSTRACT

The physical as well as the chemical parameters of six different kiwifruit, *Actinidia* spp. cultivars such as Hayward, Monty, Bruno, Red Kiwi, Abbott and Allison were analysed during the study period. The fruit length, fruit diameter, fruit diameter to length ratio and fruit weight were highly significant ($P < 0.01$) during both the analysis year 2016 and 2017. The average fruit length for both the study period was measured the longest in Monty (6.38 cm) followed by Abbott (5.99 cm) and Red kiwi had the shortest fruit length (4.10 cm). Similarly, the fruit diameter was measured the highest in Bruno (4.84 cm) followed by Monty (3.90 cm) and the lowest in Red Kiwi (3.34 cm). The highest fruit weight was measured in Bruno (87.96 g) followed by Monty (75.23 g) and the lowest in Red Kiwi (34.94 g). The total soluble solid (TSS) was recorded maximum in Red Kiwi (14.59 °Brix) followed by Hayward (13.61 °Brix) and minimum in Allison (9.60 °Brix). While, titratable acidity (TA) percentage was recorded maximum in Allison 0.85% and minimum in Red Kiwi with 0.46% and Hayward with 0.56%. Red Kiwi, Hayward and Bruno observed as good cultivars in eastern mid-hills region of Nepal.

Keywords: Analysis, cultivars, kiwifruit, red Kiwi

INTRODUCTION

Kiwifruit (*Actinidia* spp.) originating from China is a deciduous vine which was introduced to the world market from New Zealand in the 1950s Barboni *et al.*, (2010). Hayward, Bruno and Allison are regarded as the most important commercial cultivars. These cultivars were selected from New Zealand and are popular ones in the world. While in Nepal, the cultivars; Red Kiwi for early season, Bruno for mid season and Hayward for late season are selected for cultivation (Paudyal, 2013). Kiwifruit is a good source of antioxidant substances and organic compounds such as amino acids, sugars, proteins, minerals and vitamins necessary for the human body. Due to its nutritive value as well as the antioxidant properties, there is increasing interest of the crop production in the recent years Tavarini *et al.*, (2008). During the fruit ripening process there are several biochemical, and physiological changes which determine the final

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fruit quality attributes. The fruit has good vitamin C content, exceeding that of pears, apples and oranges. Therefore, kiwifruit has been described as ‘the king of fruit’ (Xu and Zhang, 2003). Consumption of kiwifruit has several health benefits in human, catharsis and alleviation of intestinal diseases. This benefit has widened the consumption rate of the fruits by people of different age groups (Ferguson and Huang, 2007).

The increasing population of the consumers towards the consumption of the fruits has shown an ample space for the expansion of the area under the crop. The fruits can even be stored for long time in cold storage. Shahkoomahally and Ramezani, 2015 had reported that although fruits remain edible for more than 5 months at 0°C, the best quality will remain for 3 to 4 months. Along with its fresh use, the fruits can be used as processed products and has good industrial value too. The importance and uses of the fruits has created an environment towards its study for accessing the quality of the fruit and selection of the good cultivar for commercial scale production. Thus, the main aim of the study was to evaluate the physical and chemical properties of six different kiwifruit cultivars grown in the eastern mid-hills condition to determine the good cultivar for the commercial scale production and recommend for the region.

MATERIALS AND METHODS

PLANT MATERIALS

During the study period, 2016 and 2017, the fruits at fully matured stage were harvested from the six different cultivars (Hayward, Monty, Bruno, Red Kiwi, Abbott and Allison) that are being grown and maintained under the same management practice at Agricultural Research Station, Pakhribas, Dhankuta at an altitude of 1800 m masl. Immediately after the harvest of the fruits, they were taken to the laboratory of Agricultural Research Station, Pakhribas for the fruit quality analysis process.

EXPERIMENTAL DESIGN

The study was conducted in Completely Randomized Design (CRD). The six cultivars for the evaluation were regarded as the treatments. A total of fifteen fruits from each cultivars were collected and made three replicates where, each replicate had five fruits for evaluation and analysis.

PHYSICAL PROPERTIES

The fruits selected as a sample were of uniform shape, size and weight which were separated from the harvested bulk. During the data recording period, possible morphological characteristics of the fruits were recorded. Each fruit was weighed individually in a digital balance for fresh fruit weight. With the help of a digital vernier caliper, length and diameter of the fruits as well as the stalk length of fruit were measured. Similarly, the fruit diameter to length ratio was calculated during the study period.

CHEMICAL PROPERTIES

From the sampled fruits, total soluble solids (TSS) of the fruit juice was determined with the help of a hand held refractometer which was calibrated using distilled water and measured in ($^{\circ}$ Brix). Titratable acidity (TA) of the juice extracted from the fruits was estimated by titration with 0.1 N NaOH solution. It is expressed in percentage.

STATISTICAL ANALYSIS

The data collected during the study were analyzed using Genstat 18th edition software. Analysis of variance (ANOVA) was performed and differences among the means were determined for significance using Least Significance Difference test.

RESULTS AND DISCUSSION

FRUIT CHARACTERISTICS

The fruit characteristics; fruit length, fruit diameter and fruit diameter to length ratio of kiwifruit in eastern mid-hills in 2016 and 2017 are provided in Table 1. Average fruit length, fruit diameter and fruit diameter to length ratio were found highly significantly different at ($P < 0.01$) during the both years. The average fruit length was maximum in cultivar Monty with 6.36 cm during 2016 and with 6.40 cm during 2017 while, cultivar Red Kiwi had the minimum of the fruit length in both the years with 3.94 cm in 2016 and 4.25 cm in 2017. The average fruit length for both the years showed that, Monty is the longest fruit (6.38 cm) followed by Abbott (5.99 cm) and Red Kiwi is the shortest one (4.10 cm). Comparing the fruit diameter, Bruno had the highest during both the years; 2016 and 2017 and the average mean of the both years was 4.84 cm followed by Monty 3.90 cm and the least was in Red Kiwi with 3.34 cm. Though the fruit size was small in Red Kiwi, the fruit diameter to length ratio was good as compared to other cultivars. The maximum fruit diameter to length ratio was observed in Bruno and Red Kiwi during the year 2016 and 2017. The average mean fruit diameter to length ratio was maximum in the cultivar Bruno with

0.85 followed by Red Kiwi with 0.82 while, the least was calculated in Monty with 0.61.

Table 1: Fruit characteristics of kiwifruit in eastern mid-hills (2016 and 2017)

Varieties	Fruit length (cm)			Fruit diameter (cm)			Fruit diameter/length ratio		
	2016	2017	Mean	2016	2017	Mean	2016	2017	Mean
Abbott	6.08ab	5.90ab	5.99b	3.64bc	3.75b	3.70bc	0.60b	0.64b	0.62b
Hayward	6.04ab	5.89ab	5.97b	3.51c	3.59b	3.55cd	0.58b	0.61b	0.60b
Bruno	5.58c	5.77b	5.68b	4.76a	4.92a	4.84a	0.85a	0.85a	0.85a
Monty	6.36a	6.40a	6.38a	3.84b	3.95b	3.90b	0.61b	0.62b	0.61b
Red Kiwi	3.94d	4.25c	4.10c	3.26d	3.42b	3.34d	0.83a	0.81a	0.82a
Allison	5.83bc	6.01ab	5.92b	3.67bc	3.91b	3.79bc	0.63b	0.65b	0.64b
Mean	5.64	5.70	5.67	3.78	3.92	3.85	0.68	0.70	0.69
F-test	**	**	**	**	**	**	**	**	**
LSD	0.42	0.52	0.32	0.19	0.54	0.29	0.05	0.09	0.06
CV%	5.1	6.2	3.9	3.5	9.3	5.1	5.4	9.2	5.9

*, Significant at $P \leq 0.05$. **, $P \leq 0.01$. LSD, least significant difference. CV, coefficient of variance, value with same letters in the column is not significantly different at 5% by DMRT

The stalk length and the fruit weight of six cultivars of kiwifruit in eastern mid-hills during 2016 and 2017 are presented in the Table 2. The maximum stalk length of the fruit was recorded in cultivars Bruno, Allison and Monty in both the year 2016 and 2017. While, the mean of the both year shows that Bruno with 3.23 cm had the longest stalk length followed by Allison with 3.17 cm and the least in Red Kiwi with 2.03 cm. Highly significant difference in the fruit weight was observed during both the years; 2016 and 2017. The average fruit weight was maximum in cultivar Bruno 87.96 g followed by Monty 75.23 g and the least in Red Kiwi 34.94 g.

Table 2: Fruit weight and stalk length of kiwifruit in eastern mid-hills (2016 and 2017)

Varieties	Stalk length (cm)			Fruit weight (g)		
	2016	2017	Mean	2016	2017	Mean
Abbott	2.95a	2.74ab	2.84a	68.74c	60.30b	64.50bc
Hayward	2.64ab	2.99a	2.81a	58.94d	56.30b	57.63c
Bruno	3.20a	3.25a	3.23a	87.76a	88.10a	87.96a
Monty	2.94a	3.15a	3.05a	77.93b	72.50ab	75.23b
Red Kiwi	1.99b	2.08b	2.03b	35.26e	34.60c	34.94d
Allison	3.22a	3.11a	3.17a	68.08c	60.00b	64.06bc
Mean	2.82	2.89	2.86	66.12	62.00	64.05
F-test	*	*	*	**	**	**
LSD	0.68	0.72	0.65	9.04	19.05	12.42
CV%	16.4	16.9	15.5	9.2	20.7	13.1

*, Significant at $P \leq 0.05$. **, $P \leq 0.01$. LSD, least significant difference. CV, coefficient of variance, value with same letters in the column is not significantly different at 5% by DMRT

TOTAL SOLUBLE SOLID AND TITRATABLE ACIDITY PERCENTAGE IN FRUITS

The total soluble solid and titratable acidity percentage in six cultivars of kiwifruit in eastern mid-hills during 2016 and 2017 are presented in the Figure 1 and 2. In the present study, the total soluble solid (TSS) content in the fruit was maximum in the cultivar Red Kiwi and Hayward during the year 2016 and 2017. The average TSS of both the year was maximum in Red Kiwi 14.59 °Brix followed by Hayward with 13.61 °Brix and the least in Allison 9.60 °Brix.

Similarly, the titratable acidity percentage was maximum in the cultivar Allison followed by Abbott during both the years; 2016 and 2017. The average titratable acidity of cultivar Allison was maximum with 0.85% followed by Abbott with 0.71% and minimum in the cultivars Hayward 0.56% and Red Kiwi with 0.46%.

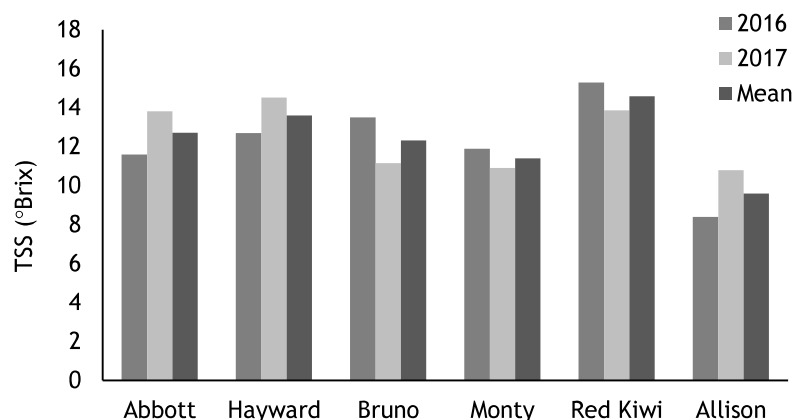


Figure 1. Total Soluble Solid (TSS) °Brix in fruits during 2016 and 2017

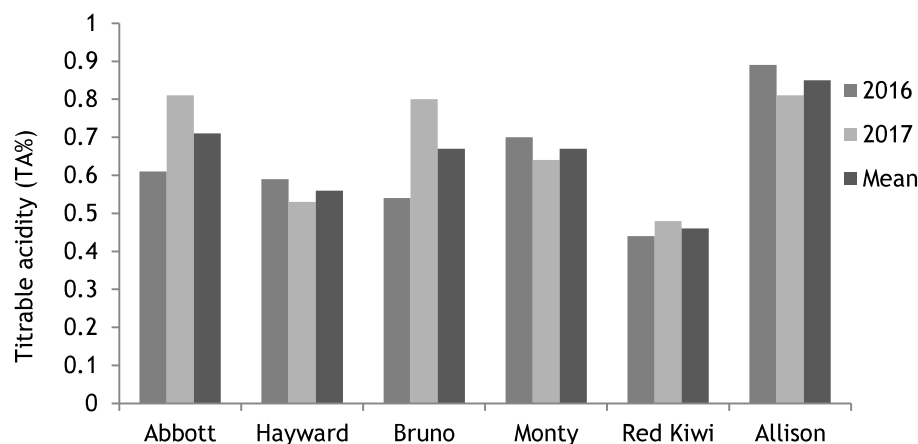


Figure 2. Titrable acidity percentage (TA%) in fruits during 2016 and 2017

According to the results, there was significant difference in the fruit length and diameter among the tested six cultivars during 2016 and 2017. The average fruit length during both the years ranged from 6.38 cm in Monty to 4.10 cm in Red Kiwi. In case of the fruit diameter, Bruno had the maximum of fruit diameter with 4.76 cm and 4.92 cm during 2016 and 2017 while, Red Kiwi had the minimum with 3.26 cm and 3.42 cm during 2016 and 2017 respectively. Similar results were reported by Paudyal (2013) that, the fruit length was highest in Bruno and Monty (6.66 cm) and the lowest in Red Kiwi (4.59 cm). In contrast to our result, Popovic *et al.*, (2002) had reported that Bruno had the longest and Monty had the shortest fruit length while, Hayward had the

maximum and Monty the minimum fruit diameter. Our results agree with the finding by Dhakal *et al.*, (2017) where they have reported that Red Kiwi had the shortest fruit length (38.54 mm). In contrast to our result, Dhakal *et al.*, (2017) had reported that the longest fruit length was measured in Bruno (59.56 mm) followed by Allison (58.60 mm). In our result, fruit width was highest in Monty (45.55 mm) followed by Hayward Round (40.26 mm) and lowest fruit width was measured in Red Kiwi (32.81 mm). Significant difference in the fruit weight was observed during the both the years 2016 and 2017. The result was in contrast to the previous studies findings as the fruit weight was maximum in Hayward and the least in Red Kiwi (Paudyal, 2013). Similarly, Dhakal *et al.*, (2017) has also reported that the fruit weight was the highest in Hayward Round (64.37 g) followed by Allison (55.40 g) and the lowest in Red Kiwi (35.04 g). Poudel *et al.*, (2017) has also reported that the maximum fruit weight was observed in the cultivar Bruno followed by Monty and the minimum from Red Kiwi. Similar result was observed by Celik *et al.*, (2007) who has reported that the average weight of Hayward fruit was found to be the maximum with 72.28 g and the highest fruit length was measured in Monty (6.36 cm) followed by Abbott (6.08 cm).

The total soluble solids (TSS) content in the fruits is considered as an index of fruit ripening. The increase in TSS signifies the conversion of starch to the soluble sugars. In our study the average TSS of both the years were maximum in Red Kiwi 14.59 °Brix followed by Hayward with 13.61 °Brix and the least in Allison 9.60 °Brix. In contrast to the result, the titrable acidity was maximum in Allison (0.85%) and the minimum in Red Kiwi (0.46%). Shahkoomahally and Ramezani (2015) had reported that SSC was 13.72 % and TA was 0.6 % in Hayward variety after 30 days of harvesting. Similar to our result was observed by Sekeret *et al.* (2003) where, the TSS varied from 11.91 to 12.74% for cv. 'Hayward' at harvesting time. Zenginbal *et al.* (2005) had reported that TSS varied from 9.5 to 10.0% and 14 to 15% for cv. 'Hayward'. In the other study, Wismer *et al.* (2005) had reported 14.5 °Brix of TSS in Hayward which is similar to the findings of the present study. Similarly, Nishiyama *et al.* (2004) reported that the fruits of Abbott contain the lowest concentration of ascorbic acid as compared to the tested cultivars six *A. deliciosa*, seven *A. chinensis*, two *A. rufa*, and six *A. arguta*.

CONCLUSION

The present result of the study indicated that the kiwifruit can commercially be cultivated in the eastern mid-hills condition using the cultivars Red Kiwi, Hayward and Bruno. Along with the cultivars we have to have a study regarding the altitude for the production area as well the research has to be more focused on the time of harvesting of the crops, as the cultivars vary in the maturity and the ripening time. Thus, further study and experiments are required to explore the physico-chemical changes during the storage of the fruits for maintaining the quality of the product during the storage period.

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