Journal of Agriculture and Food Research 2 (2020) 100061

Contents lists available at ScienceDirect

Journal of Agriculture and Food Research

journal homepage: www.journals.elsevier.com/journal-of-agriculture-and-food-research/

Mineral composition, pigments, and postharvest quality of guava cultivars commercially grown in India

Priyanka Kumari [a], Abhay Mankar [a], Kumari Karuna [a], Fozia Homa [b], Kulyash Meiramkulova [c], Mohammed Wasim Siddiqui [d,*]

[a] Department of Horticulture (Fruit and Fruit Technology), Bihar Agricultural University, Sabour, Bhagalpur, 813210, Bihar, India
[b] Department of Statistics, Mathematics, and Computer Application, Bihar Agricultural University, Sabour, Bhagalpur, 813210, Bihar, India
[c] Department of Environmental Engineering and Management, L.N. Gumilyov Eurasian National University, Satpayev Street 2, Nur-Sultan, 010000, Kazakhstan
[d] Department of Food Science and Postharvest Technology, Bihar Agricultural University, Sabour, Bhagalpur, 813210, Bihar, India

ARTICLE INFO

Keywords:
Pigments
Postharvest quality
Primary nutrients
Psidium guajava
Trace elements

ABSTRACT

Five guava cultivars (one red and four white fleshed) were characterized for primary elements (N, P, K), micro elements (Fe, Mn, Zn), pigments (carotenoids and chlorophylls), and other postharvest fruit quality characteristics. A significant variation was recorded in fruit weight (~75–354 g), fruit length (~33–73 mm), fruit diameter (~41–86 mm), specific gravity (1.04–1.19) and fruit shape index (0.73–1.08). A wide variation in TSS (~13-10%), titratable acidity (0.42–0.77%), sugar/acid ratio (~7–13) and total sugar (4.02–6.88%) content was also recorded. There was a significant variation in pigments (mg/100 g) such as chlorophyll-a (~5–12), chlorophyll-b (~2–4) and carotenoids (~33–66) among different cultivars. Primary nutrients such as N, P, and K were found to vary between 1.00-1.70, 0.12–0.15 and 2.60–3.28%, respectively. Micronutrients such as Fe, Zn, and Mn were varied between 42.25-64.23, 13.88–18.38, and 2.93–8.23 ppm, respectively. As there is limited information available on elemental and other postharvest characteristics of guava cultivars, results of this work could be useful in the development of new varieties with elevated nutrient potential.

1. Introduction

Guava (*Psidium guajava* L.) is an important commercial fruit crop of tropical and subtropical world, where it also thrives well in the wild. Therefore, it is also known as “apple of the tropics” and has earned the popularity as “Poor man's apple” due to its plenty availability and low cost to every person during the season. Being one of the most nutritious and delicious fruits with refreshing taste and pleasant flavor, guava is liked by the consumers. The total guava production in India is 3.20 million tons from an area of 0.24 million hectares, and productivity of 13.6 t/ha. It has high nutritive and antioxidant potential value and contains 3–6 times higher vitamin A and C than oranges [1–3]. It plays an important role in reducing nutritive disorders due to deficiency of vitamin C in human health. It also has vitamin B_1 (thiamin), B_2 (riboflavin), B_6 (niacin), iron, calcium and high fiber (Dhaliwal and Dhillon, 2003). The flavoring volatiles and biochemical composition resembling nutritional antioxidant properties has been well studied in some varieties of guava [3–5].

On the other hand, the information on elemental composition of guava is scarcely available. Recently, a few studies demonstrated the elemental composition of guava. Ali et al. [6] evaluated nutritional value of white and red fleshed guava without describing the variety names. They revealed that two varieties had appreciable amount of potassium (38.23, 37.29 mg/100g), sodium (17.03, 12.67 mg/100g), calcium (12.68, 11.82 mg/100g), magnesium (7.22, 6.17 mg/100g) and iron (3.66, 1.57 mg/100g). The characterization of genetic resources is of great importance to develop new varieties [7]. Considering the lack of information on elemental composition, the present study was conducted to evaluate different promising guava cultivars for their mineral content and postharvest qualities.

2. Materials and Methods

2.1. Plant material and growing site

Fruits of five guava cultivars were collected for two consecutive years (2015 and 2016) from Horticulture farm, Bihar Agricultural University, Sabour, India. Fruits were harvested at commercial maturity (firm and

* Corresponding author.
E-mail address: wasim_serene@yahoo.com (M.W. Siddiqui).

https://doi.org/10.1016/j.jafr.2020.100061
Received 11 May 2020; Received in revised form 17 July 2020; Accepted 18 July 2020

Table 1
Physical characteristics of different guava cultivars. Values (mean ± S.D., n = 4) in the same column with different letters are significantly different ($p < 0.05$).

Varieties	Fruit weight (g)	Fruit length (mm)	Fruit diameter (mm)	Specific gravity	Fruit shape index
Allahabad Safeda	118.38 ± 4.84^{d}	45.28 ± 3.96^{c}	61.62 ± 3.18^{b}	1.04 ± 0.03^{b}	0.73 ± 0.06^{b}
Lalit	74.88 ± 9.04^{e}	32.73 ± 0.37^{d}	41.25 ± 1.53^{c}	1.09 ± 0.06^{ab}	0.79 ± 0.04^{b}
Salithong	353.75 ± 7.31^{a}	65.65 ± 3.33^{b}	86.35 ± 3.48^{a}	1.07 ± 0.03^{ab}	0.76 ± 0.07^{b}
Kimchu	307.00 ± 8.96^{b}	64.64 ± 4.68^{b}	80.89 ± 7.54^{a}	1.12 ± 0.13^{ab}	0.80 ± 0.02^{b}
KG guava	226.75 ± 12.28^{c}	73.03 ± 2.96^{a}	67.83 ± 1.69^{b}	1.19 ± 0.05^{a}	1.08 ± 0.08^{a}

light green stage) when they are normally eaten by the consumers. Fruits with any infection or disease incidence were discarded.

All cultivars were grown synchronously in the same field and subjected to similar cultural practices (irrigation, nutrients, pesticide application, etc.) and environmental conditions to minimize the influence of pre- and post-harvest factors on cultivar-linked variability. The experimental field is situated at longitude 87º2'72" east and latitude 25º15'40" North at an altitude of 46 m above mean sea level in the heart of the vast Indo-Gangetic plain of North India, south of river Ganga.

2.2. Agronomic attributes

2.2.1. Weight, size, and specific gravity

The fruits were weighed carefully with the help of electronic balance in gram. The length and breadth were recorded with the help of a varnier calipers in mm and average size was worked out. The specific gravity of fruit was recorded from the selected fruit by measuring their weight (gm) in air by the volume of the fruit obtained by water displacement method.

2.2.2. Total soluble solids, acidity, and total sugar contents

Total soluble solids (TSS) of fruits were recorded with the help of a digital hand refractometer. Titratable acidity was determined using titration method [8] and expressed as percentage of citric acid. Total sugar contents were estimated by using copper titration method as devised by Lane and Eyon [9]. The sugar/acid ratio was determined by dividing the sugar content of fruits by their acidity.

2.3. Pigment analyses

2.3.1. Chlorophyll (a & b) and carotenoids

Pigments (chlorophylls and carotenoids) were measured according to previously described method [10]. The quantitative determination of chlorophyll a (chl. a), chlorophyll b (chl. b) and carotenoids in certain whole pigment extract depends mostly on solvent system. Herein, samples (1 g) were extracted with 80% acetone until pellets were colourless. Supernatants were combined and absorbance was measured at 452.5, 646.8 and 663.2 nm. Pigment concentrations were calculated using equations appropriate for used solvent (80% acetone) according to Lichtenthaler and Buschmann [10].

$$\text{chl a (mg/g FW)} = (12.25 \text{ x } A_{663.2} – 2.79 \text{ x } A_{646.8}) \text{ x V/1000 x m}$$

$$\text{chl b (mg/g FW)} = (21.50 \text{ x } A_{646.8} – 5.10 \text{ x } A_{663.2}) \text{ x V/1000 x m}$$

$$\text{car (mg/g FW)} = [4.75 \text{ x } A_{452.5} – 0.226 \text{ x (chl a + chl b)}] \text{ x V/1000 x m}$$

Where.

V = combined extract volume (mL)
M = sample dry weight (g)

2.3.2. Lycopene

For determining the lycopene content, 1 g of pulp was ground with 50 mL of hexane-ethanol-acetone (2:1:1, v/v). The extract was taken in separating funnel in which 10 mL of distilled water was added. Upon separation of phases after 5 min, lower phase was discarded. After filtration, the absorbance of upper phase was recorded at 502 nm using a UV–vis spectrophotometer and result was expressed in mg/100 g [11].

2.4. Elemental analyses

2.4.1. Analysis of fruit N, P, and K contents

Nitrogen was determined by Kjheldahl method. The phosphorus content was determined by using ammonium molybdate [12]. The color intensity was measured at 440 nm in a spectrophotometer. Potassium was determined with flame photometry technique using corning flame photometer, U.K [13]. All the results were present in per cent.

2.4.2. Analysis of Fe, Mn, and Zn contents

The estimation of micro elements (Fe, Mn, and Zn) was carried out using the di-acid digested material in an Atomic Absorption Spectrophotometer. The results were presented in ppm.

2.5. Statistical analysis

Data of two years were pooled and subjected to analysis of variance (ANOVA). The significance of the difference between means was determined by Duncan's multiple range test ($p < 0.05$) using SAS (SAS Inst., Cary, NC, USA).

3. Results and discussion

3.1. Agronomic attributes

3.1.1. Fruit weight

There was a significant difference in fruit weight among all cultivars as depicted in Table 1. Fruit weight was ranged from 74.9 to 353.75 g. The order of hierarchy was Salithong > Kimchu > KG guava > Allahabad Safeda > Lalit. The variation in fruit weight may be due to phenotypic and genotypic influence over different cultivars, which is in conformity with the findings of Deshpande [14] and Jana et al. [15]. Values observed in this experiment were relatively similar to previous reports of Biswas [16] and Ram et al. [17] as 310 g and 75–300 g, respectively, in different guava cultivars. The recorded fruit weight was lower than those reported by Hoque et al. [18] in Kazi Piara (446.3 g) but higher than values observed by Girwani et al. [19], Aulakh [20] and Gohil et al. [21] as 16–167.50, 49.50–116 and 105–261.7 g, respectively. It has been suggested that growing localities affect fruit weight of a particular cultivar. Similarly, while studying with different guava cultivars under different agro-climatic condition, Jana et al. [15], Patel et al. [22] and Kaur et al. [23] reported fruit weight to vary as a function of cultivars.

3.1.2. Fruit length

A significant difference in fruit length was observed among cultivars (Table 1). Maximum fruit length was recorded in KG Guava (73.04 mm) and Lalit recorded the minimum fruit length (32.73 mm). The length of fruit in decreasing order was KG Guava > Salithong > Kimchu > Allahabad safeda > Lalit. The variation in fruit length can be attributed to genetic constitution of a cultivar [23]. The observed results are in agreement with previous reports of Pandey et al. [24] and Patel et al. [25], who reported the variation in fruit length ranging between 58.3 to 72.7 mm and 51.6–70.8 mm, respectively, in different guava cultivars. The values recorded in this work were lower than those reported by Mahour et al. [26]. Their values ranged between 35.7 to 87.9 mm in Allahabad Safeda and China red. Recently, Methela et al. [7] characterised 12 guava cultivars and reported fruit length to vary from 44.3 (cv.

Table 2
Biochemical characteristics of different guava cultivars. Values (mean ± S.D., n = 4) in the same column with different letters are significantly different (p < 0.05).

Varieties	Total soluble solids (°B)	Titratable acidity (%)	Sugar/Acid ratio	Total sugar (%)
Allahabad Safeda	9.98 ± 1.53^{e}	0.42 ± 0.05^{c}	13.31 ± 2.13^{a}	5.57 ± 0.54^{b}
Lalit	13.10 ± 0.41^{a}	0.53 ± 0.06^{b}	13.16 ± 1.61^{a}	6.88 ± 0.74^{a}
Salithong	11.35 ± 0.79^{b}	0.77 ± 0.05^{a}	6.78 ± 0.72^{b}	5.18 ± 0.37^{b}
Kimchu	10.13 ± 0.39^{cd}	0.73 ± 0.09^{a}	6.72 ± 0.98^{b}	4.84 ± 0.16^{b}
KG guava	10.60 ± 0.61^{bc}	0.48 ± 0.03^{bc}	8.37 ± 0.55^{b}	4.02 ± 0.09^{c}

Table 3
Pigment contents in different guava cultivars. Values (mean ± S.D., n = 4) in the same column with different letters are significantly different (p < 0.05).

Varieties	Lycopene (μg/100g FW)	Chlorophyll a (mg/100g FW)	Chlorophyll b (mg/100g FW)	Carotenoid (mg/100g FW)
Allahabad Safeda	nd	4.51 ± 0.59^{d}	2.29 ± 0.32^{b}	33.04 ± 0.83^{d}
Lalit	17.69 ± 0.80	8.35 ± 0.56^{b}	2.71 ± 0.23^{b}	49.35 ± 0.40^{b}
Salithong	nd	11.69 ± 0.10^{a}	4.03 ± 0.29^{a}	65.96 ± 0.65^{a}
Kimchu	nd	5.47 ± 0.10^{d}	1.62 ± 0.15^{c}	34.69 ± 2.71^{d}
KG guava	nd	6.87 ± 1.73^{c}	2.82 ± 0.68^{b}	40.57 ± 4.00^{c}

nd = Not detectable.

Sayedi) to 93.8 mm (cv. Chiangmai long). Fruit size is purely a varietal character, which is influenced by environment conditions, growing seasons and locations. Marak and Mukunda [27], Biradar and Mukunda [28] and Patel et al. [25] also reported the varying range of fruit length in different guava cultivars as 56.5–42.6, 57.1–44.8, and 65.6–50.4 mm, respectively, when grown under different agro-climatic conditions.

3.1.3. Fruit diameter

It is evident from Table 1 that there were significant variations among cultivars with respect to fruit diameter. The highest fruit diameter was recorded in cultivar Salithong (86.35 mm), whereas the lowest was recorded in Lalit (41.25 mm). The order of the hierarchy was Salithong > Kimchu > KG guava > Allahabad Safeda > Lalit. Recently, Methela et al. [7] morphologically characterized different indigenous and exogenous guava cultivars and reported fruit diameter to vary from 42.7 to 88.0 mm. The values obtained in this experiment are relatively similar as recorded by Mahour et al. [26]. While studying with different guava cultivars, they found that average fruit diameter ranges from 84.4 to 35.6 mm. The values recorded in this experiment were higher than those reported by Pandey et al. [24], Patel et al. [25] and Babu et al. [29] showing diameter of guava fruits, belonging to different cultivars, ranging between 58.3-72.7, 56.3–69.1 and 55.5–66.3 mm. Varietal variation for physical characters have also been reported by Gohil et al. [21] and Singh et al. [30]. This variation in fruit diameter may be attributed to phenotypic and genotypic interactions among the cultivar [6].

3.1.4. Specific gravity

Specific gravity is an index for determining of maturity of fruits. Specific gravity (SG) of fruits is proved to be related to their internal characteristics such as dry matter, soluble solids, or physical disorders. In the present investigation, no significant variation in SG was recorded among cultivars (Table 1). The SG of fruits ranged between 1.04 and 1.19 being the highest in KG, whereas Allahabad Safeda recorded the lowest SG. The specific gravity of fruits in decreasing order was KG guava > Kimchu > Lalit > Salithong > Allahabad Safeda. The results of this investigation was somewhat similar to previous report of Sharma et al. [31], who reported SG to vary between 1.04 and 1.15 in different cultivars.

3.1.5. Total soluble solids

TSS play an important role to improve the quality of fruits and gives a rough idea of the sweetness. The highest TSS was obtained in cultivar Lalit (13.10 °Brix), whereas the lowest value was recorded in cv. Allahabad Safeda (9.98 °Brix). The order of the hierarchy of total soluble solid was Lalit > Salithong > KG guava > Kimchu > Allahabad Safeda (Table 2). Several researchers [23]; Patel et al., 2011) also reported the genotypic variation in TSS content in different guava cultivars. The results of this experiment were in agreement with previous reports of Marak and Mukunda [27], who observed TSS to be ranged between 13.80 and 8.50 °Brix. The value reported in this work were quite higher than those reported by Adrees et al. [32] and Mahour et al. [26] in different guava cultivars as 11.87 and 11.50–4.0 °Brix in Allahabad Safeda, respectively. Whereas, Gohil et al. [21] and Jana et al. [15] reported higher TSS values in different guava cultivars varying between 16.90 and 10.40 °Brix and 14.36 °Brix (in summer). There might be several reasons for variations in TSS content including season, soil, and climatic conditions (Lakade et al., 2011). The variation may also be due to the phenotypic and genetic constitution of some cultivars, which might had necessitated consumption of nutrients and sinking more carbohydrates into the fruit, thus producing larger fruits with higher TSS [27].

3.1.6. Titratable acidity

There was a significant difference (p < 0.05) in titratable acidity (TA) content among guava cultivars ranging from 0.42 to 0.77% (Table 2). The highest TA content was observed in cultivar Salithong, whereas the lowest in Allahabad Safeda. The TA in decreasing order was: Salithong > Kimchu > Lalit > KG Guava > Allahabad Safeda. The genotypic variation in TA content in different guava cultivars has also been reported by several researchers. The results are in agreement with the previous reports of Babu et al. [29], who also reported the variation in TA content ranging between 0.28 and 0.70%. Values recorded in this work are quite higher than those reported by Mahour et al. (2011) in different guava cultivars as 2.75–0.16%, respectively. Whereas, Adrees et al. [32] while studying with Gola variety of guava observed higher TA content (1.67%). The cultivar itself has been identified as a determining factor of the composition irrespective of commodity [33]. Being a genetical character of the individual variety, the acidity of fruit is directly related to growth and development of fruit that tends to alter during growth and development [34].

3.1.7. Sugar/acid ratio

In fruits, sugars impart the sweetness while sugars and organic acids together influence its flavor. Sugar/Acid ratio among guava cultivars was ranged from 6.78 to 13.31 (Table 2). The highest value was recorded in cultivar Allahabad Safeda, whereas the lowest value was recorded in Salithong. The order of hierarchy was Allahabad Safeda > Lalit > KG guava > Kimchu > Salithong. This variation may be a varietal character that is associated with total sugar content and titratable acidity of fruits as also reported by Agrawal [35] and Negi et al. [36] in different guava cultivars. The variation in sugar/acid ratio might be affected by heavy rainfall, temperature, and humidity at the time of fruit development and growth [35].

3.1.8. Total sugar

Total sugars are considered as an important factor for the quality of fruits. With a significant variation, the sugar content among guava cultivars ranged from 4.02 to 6.88% (Table 2). The highest value was observed in cultivar Lalit, whereas the lowest in KG guava. The order of hierarchy was Lalit > Allahabad Safeda > Salithong > Kimchu > KG guava. The result of this experiment is in agreement with previous reports of Adrees et al. [32], who reported sugar content to be the highest in the cultivar Hong Kong (6.36%) in relation to other guava cultivars. Kaur et al. [23] reported that sugar content ranges between 3.60-3.41% in cultivars, Allahabad Safeda and Lucknow-49, which is lower than the

Table 4
Primary and micro nutrient elements in different guava cultivars. Values (mean ± S.D., n = 4) in the same column with different letters are significantly different ($p < 0.05$).

Varieties	Nitrogen (%)	Phosphorous (%)	Potassium (%)	Iron (ppm)	Manganese (ppm)	Zinc (ppm)
Allahabad Safeda	1.70 ± 0.10[a]	0.14 ± 0.03[a]	3.28 ± 0.25[a]	42.25 ± 4.62[b]	8.23 ± 0.86[a]	13.88 ± 0.85[c]
Lalit	1.11 ± 0.05[b]	0.15 ± 0.01[a]	2.60 ± 0.14[c]	50.45 ± 8.30[b]	7.60 ± 0.90[a]	13.80 ± 2.87[c]
Salithong	1.16 ± 0.08[b]	0.14 ± 0.02[a]	2.88 ± 0.17[b]	64.23 ± 5.57[a]	5.60 ± 0.69[b]	18.38 ± 3.39[a]
Kimchu	1.10 ± 0.15[b]	0.13 ± 0.01[a]	2.78 ± 0.17[b]	46.05 ± 4.33[b]	2.93 ± 0.72[c]	17.30 ± 3.95[a]
KG guava	1.00 ± 0.12[b]	0.12 ± 0.02[a]	2.75 ± 0.17[b]	42.88 ± 5.60[b]	2.98 ± 0.59[c]	14.75 ± 2.91[b]

recorded values. The value recorded in this investigation is lower than those of reported by Lakade et al. (2010), Patel et al. [22] and Ali et al. (2014) in different guava cultivar as 6.32–8.47, 6.04–8.39 and 8.88–8.43%, respectively. Guava is a climacteric fruit and considerable changes may occur in sugar content during fruit ripening as reported by Dube et al. [37]. The significant variation in sugar contents in fruit of guava cultivars might have occurred due to genetic or phenotypic features or due to maturity/ripening stage [32,35].

3.2. Pigment analyses

3.2.1. Lycopene

Lycopene is a powerful natural antioxidant, which imparts pink coloration to the fruit pulp in guava. The lycopene content of guava pulp was assessed in cv. Lalit, which was found to be 17.69 μg/100 g FW. This is in conformity with the findings of Lakade et al. [38] and Chandrika et al. [39]. The cultivar itself has been identified as a determining factor of the composition and content of plant pigments [34].

3.2.2. Chlorophylls and carotenoids

The chlorophyll and carotenoid contents in guava have a positive function in the epithelization process and affect the cell cycle development of the fibroblasts. Guava is a good source of carotenoid and it is a promising fruit for use in pharmacological products designed for antioxidant activity. A significant difference among cultivars with respect to chlorophyll as well as carotenoid contents was observed (Table 3). Chlorophyll-a, chlorophyll-b and carotenoid contents were found to be 4.51 to 11.69, 1.62 to 4.03 and 65.96 mg/100 g fw of peel, respectively. The highest chlorophyll-a, chlorophyll-b and carotenoid content was observed in cultivar Salithong whereas; the cv. Allahabad Safeda had the lowest value of chlorophyll-a and carotenoid. The lowest chlorophyll-b contents were recorded in cultivar Kimchu. In this experiment, Chlorophyll-a content was approximately three times higher than chlorophyll-b. The order of hierarchy of chlorophyll-a and carotenoid was Salithong > Lalit > KG > Kimchu > Allahabad Safeda. The genotypic variation in chlorophyll and carotenoids contents in different guava cultivars has also been reported by several researchers. Being a genetical character of a genotype, chlorophyll content directly related to growth and development of fruit and it tends to decrease but carotenoids content increases with advancing maturity [40]. The changes in chlorophylls are probably due to varying activity of chlorophyll degrading enzymes such as chlorophyllase, chlorophyll oxidase, and peroxidase during ripening [41]. The increase in carotenoids has been reported due to chlorophyll degradation and synthesis of carotenoid [34].

3.3. Primary nutrients

Minerals play an important role in maintaining proper function and good human health. Inadequate intake of minerals in the diet is often associated with an increased susceptibility to infectious diseases due to the weakening of immune system. Primary nutrient contents of fruits in different cultivars are shown in Table 4. Results revealed that nitrogen (N), phosphorous (P) and potassium (K) contents of the fruits were ranged between 1.0-1.70, 0.12–0.15, and 2.60–3.28%, respectively. A significant difference among cultivars for N and K was observed, while a non-significant difference was observed for P content. The order of the hierarchy was: Allahabad Safeda > Salithong > Lalit > Kimchu > KG guava for Nitrogen, Lalit > Allahabad Safeda ~ Salithong > Kimchu > KG guava for phosphorous and Allahabad Safeda > Salithong > Kimchu > KG guava > Lalit for potassium. The result of this experiment are in line with Sharma et al. [42]. There is no available information or is very limited on elemental composition of guava fruits. However, while observing the effect of climatic conditions and morphological traits on mineral composition of several Kenyan guava cultivars, Chiveu et al. [5] opined that sampling technique, analytical method as well as genetic differences are possible factors affecting the concentration of minerals.

3.4. Micro nutrients

Trace or micro elements act as cofactor of antioxidant enzymes and protect the cell from oxidative damage. Zinc (Zn), copper (Cu) and manganese (Mn) are necessary for superoxide dismutase in both cytosol and mitochondria [43]. Micronutrient contents of fruit of different guava cultivars were observed (Table 4). The Fe, Mn, and Zn contents were differed significantly among studied cultivars ranging from 42.25 to 64.23, 2.93–8.23, and 13.88–18.38 ppm, respectively. The results are in agreement with previous reports of Beyhan et al. [44], who reported Fe, Mn, Zn, and Cu as 38.00–200, 2.10–6.30 2.90–7.30, and 1.71–6.95 ppm, while studying Feijoa genotypes (*Feijoa sellowiana* Berg). The micronutrients such as Cu, Fe, Mn and Zn were sufficient in the guava fruits for human daily requirements as suggested by Cavalcante et al. [45]. As reported by many authors, nutritional composition in fruits is influenced by many factors such as genetic, environment, climatic conditions, irrigation, fertilizing and soil conditions [46]. If it is assumed that characteristics such as soil, environment, climate factors and cultural application in the orchard where all the cultivars of guava planted were homogenous, these differences in micro element composition may be due to the genetic characteristics of genotypes [47,48].

4. Conclusion

Guava is an important and easily available fruit, which provides several nutritional benefits. There is always increasing demand of new varieties possessing specific quality specifications. Recently, fruits with unique health benefits have increased demand by consumers. Therefore to develop new varieties, characterization of available genetic resources plays an important role. In the present work, significant variation in postharvest quality attributes and elemental properties was recorded in different guava cultivars. Considering all the parameters, Allahabad Safeda and Lalit were identified as the best cultivars. Except a few parameters, there was no significant difference between both cultivars. These cultivars could be considered in breeding strategies for development of new varieties. Further research should be carried out to assess quantitative and qualitative differences among cultivars using chromatographic and molecular approaches.

Declaration of competing interestCOI

The authors declare that they have no conflict of interest.

Author contribution

PK performed the experiments, AM and KK provided with the guidance and research facilities, FH analyzed the data, MWS conceptualised the experiment, wrote and finalised the article. KM is contributed by revision and proof reading of manuscript for language editing.

Acknowledgements

The financial support and facilities provided by the Bihar Agricultural University, Sabour are duly acknowledged.

References

[1] A.Z. Mercadante, A. Steck, H. Pander, Carotenoids from guava (Psidium guajava L): isolation and structure elucidation, J. Agric. Food Chem. 47 (1) (1999) 145–151.
[2] H.M. Araújo, F.F. Rodrigues, W.D. Costa, C. de Fa Nonato, F.F. Rodrigues, A.A. Boligon, M.L. Athayde, J.G. Costa, Chemical profile and antioxidant capacity verification of Psidium guajava (Myrtaceae) fruitss at different stages of maturation, Excli J. 14 (2015) 1020–1030.
[3] P. Moon, Y. Fu, J. Bai, A. Plotto, J. Crane, A. Chambers, Assessment of fruit aroma for twenty-seven guava (Psidium guajava) ac- cessions through three fruit developmental stages, Sci. Hortic. 238 (2018) 375–383.
[4] C. Rojas-Garbanzo, J. Winter, M.L. Montero, B.F. Zimmermann, A. Schieber, Characterization of phytochemicals in Costa Rican guava (Psidium friedrichsthalianum-Nied.) fruit and stability of main compounds during juice processing-(U) HPLC-DAD-ESI-TQD-MSn, J. Food Compos. Anal. 75 (2019) 26–42.
[5] J. Chiveu, M. Naumann, K. Kehlenbeck, E. Pawelzik, Variation in fruit chemical and mineral composition of Kenyan guava (Psidium guajava L.): inferences from climatic conditions, and fruits morphological traits, J. Appl. Bot. Food Qual. 92 (2019) 151–159.
[6] D.O.M. Ali, A.R. Ahmed, E.B. Babikir, Physicochemical and nutritional value of red and white guava cultivars grown in Sudan, J. Agri-Food Appl. Sci. 2 (2) (2014) 27–30.
[7] N.J. Methela, O. Faruk, M.S. Islam, M. Mokter, Morphological characterization of guava germplasm (Psidium sp.), J. Biosci. Agric. Res. 20 (1) (2019) 1671–1680.
[8] AOAC, Official Methods of Analysis, seventeenth ed., Association of Official Analytical Chemists, Wilson Boulevard, Arlington, Virginia, USA, 2000.
[9] J.H. Lane, L. Eynon, Determination of reducing sugars by means of Fehling's solution with methylene blue as internal indicator, J. Chem. Soc. Trans. (1923) 32–36.
[10] H.K. Lichtenthaler, C. Buschman, Chlorophyll and Carotenoids: measurement and characterization by UV-VIS spectroscopy, in: Current Protocols in Food Analytical Chemistry, Wiely, New York, 2001. F4.3.1-F4.3.8.
[11] A.V. Rao, Z. Waseem, S. Agarwal, Lycopene content of tomatoes and tomato products and their contribution to dietary lycopene, Food Res. Int. 31 (1998) 737–741.
[12] H.D. Chapman, P.F. Pratt, Methods of Analysis for Soils, Plants and Water, Univ. California, Berkeley, CA, USA, 1961.
[13] M.L. Jackson, S.Y. Lee, J.L. Brown, I.B. Sachs, J.K. Syers, Scanning electron microscopy of hydrous metal oxide crusts intercalated in naturally weathered micaceous vermiculite, Soil Sci. Soc. Am. Proc. 37 (1973) 127–131.
[14] R.S. Deshpande, Varietal Evaluation and Influence of Vermicompost in Guava. M. Sc.(Agri.) Thesis, Univ. of Agric. Sci., Dharwad, 2006.
[15] B.R. Jana, P.S. Munsi, D.C. Manna, B. Das, Evaluation of guava (PsidiumguajavaL.) genotypes based on fruit morphology, Physicochemical properties and yield under eastern plateau condition, Indian J. Plant Genet. Resour. 23 (1) (2010) 25–29.
[16] S.K. Biswas, Physico-chemical composition of different varieties of guava grown at Rajshahi, Bangladesh J. Sci. Ind. Res. 34 (3/4) (1999) 327–329.
[17] R.A. Ram, D. Pandey, G.C. Sinha, Selection of promising clones of guava cv. Allahabad Safeda, Haryana J. Hortic. Sci. 26 (1–2) (1997) 89–91.
[18] M.A. Hoque, A. Bashar, Performance of nine guava varieties/lines, Food Agric. Organ. United Nation 29 (1) (1996).
[19] A. Girwani, A.S. Padmavathamma, I. Prabhakhar Reddy, K. Vanajalatha, A. Madhavi, Evaluation of guava germplasm for different horticultural traits, in: First International Guava Symposium, CISH, Lucknow, 2005, pp. 17–20. Abstract No.2.
[20] P.S. Aulakh, Performance of different guava cultivars under the arid irrigated conditions of Punjab, Progress. Hortic. 37 (2) (2005) 328–330.
[21] S.N. Gohil, B.V. Garad, H.K. Shirsath, U.T. Desai, Study on physic- chemical constituents in guava (Psidium guajava) under sub-arid zone of Maharashtra, Sci. Hortic. (Canterb.) 10 (2006) 139–147.
[22] R.K. Patel, C.S. Maiti, Bidyut C. Deka, N.A. Deshmukh, D. Roy, Variability studies in guava (Psidium guajava L.) genotypes for growth, yield and quality attributes at mid-hills of Meghalaya, Indian J. Hill Farming 24 (1) (2011) 25–29.
[23] N. Kaur, A. Kumar, P.K. Monga, P.K. Arora, Biochemical studies in fruit of guava cultivars, Asian J. Hortic. 6 (I) (2011) 122–123.
[24] D. Pandey, S.K. Shukla, R.C. Yadav, A.K. Nagar, Promising guava (Psidium guajava L.) cultivars for North Indian conditions, Acta Hortic. 735 (2007) 91–94.
[25] R.K. Patel, D.S. Yadav, K.D. Babu, A. Singh, R.M. Yadav, Growth, yield and quality of various guava (Psidium guajava L.) Hybrids/cultivars under mid hills of Meghalaya, Acta Hortic. 735 (2007) 57–59.
[26] M.K. Mahour, R. Tiwari, B.S. Baghel, Physico-chemical characteristics of different varieties/germplasm of guava in Malwa Plateau of Madhya Pradesh, Agric. Sci. Digest 32 (2) (2012) 141–144.
[27] J.K. Marak, G.K. Mukunda, Studies on the performance of open pollinated seedling progenies of guava cv. Apple Colour, Acta Hortic. 735 (2007) 79–84.
[28] S.L. Biradar, G.K. Mukunda, TG Seln. 5/12 – a promising genotype of Taiwan guava from Bangalore, Acta Hortic. 735 (2007) 85–89.
[29] K.D. Babu, R.K. Patel, D.S. Yadav, Comparative evaluation of guava selection under North Eastern region of India, Acta Hortic. 735 (2007) 99–103.
[30] S. Singh, A.K. Godara, D.S. Dahiya, Effect of packaging materials on chlorophyll and carotenoids in guava hybrid Hisar Safeda and cv L49, Haryana J. Hortic. Sci. 37 (1–2) (2008) 67–70.
[31] A.B. Sharma, M.P. Patel, K.K. Yadav, H. Dixit, FRS, Rewa; Research Report, GWM, AICRP on STF Held at BCKVV, 1989.
[32] M. Adrees, M. Younis, U. Farooq, K. Hussain, Nutritional quality evaluation of different guava varieties, Pakistan J. Agric. Sci. 47 (1) (2010) 1–4.
[33] M.W. Siddiqui, I. Chakraborty, P. Mishra, P. Hazra, Bioactive attributes of tomatoes possessing dg, ogc, and rin genes, Food Funct. 5 (2014) 936.
[34] M.W. Siddiqui, I. Chakraborty, J.F. Ayala-Zavala, R.S. Dhua, Advances in minimal processing of fruit and vegetables: a review, J. Sci. Ind. Res. (India) 70 (9) (2011) 823–834.
[35] V. Agrawal, Studies on qualitative characteristics of important guava varieties of Madhya Pradesh, Asian J. Hortic. 4 (2) (2009) 432–433.
[36] R.S. Negi, U.S. Gautam, R. Singh, Performance of important cultivars of guava (Psidium guajava) under sloppy wasteland conditions of Kaymore plateau of Madhya Pradesh, Indian J. Agric. Sci. 84 (3) (2014) 421–423.
[37] A. Dube, R. Shukla, P. Singh, Compositional and antioxidant changes in guava (Psidium guajava L.) varieties during development and ripening, Environ. Ecol. 33 (1) (2015) 33–36.
[38] S.K. Lakade, T.B. Tambe, P.A. Dhomane, V.R. Gharge, Diversity studies in quality and biochemical attributes of guava genotypes Diversity studies in quality and biochemical attributes of guava genotypes, Asian J. Hortic. 6 (1) (2011) 77–80.
[39] U.G. Chandrika, K.S.S.P. Fernando, K.K.D.S. Ranaweera, Carotenoid content and in vitro bioaccessibility of lycopene from guava (Psidiumguajava) and watermelon (Citrulluslanatus) by high-performance liquid chromatography diode array detection, Int. J. Food Sci. Nutr. 60 (7) (2009) 558–566.
[40] A.L. Dantas, S. de M. Silva, M.A.C. de Lima, R.L. Dantas, R.M.N. Mendonça, Bioactive compounds and antioxidant activity during maturation of strawberry guava fruit, Rev. Cienc. Agron. 44 (4) (2013) 805–814.
[41] N. Jain, K.L. Dhawan, S. Malhotra, R. Singh, Biochemistry of fruit ripening of guava (PsidiumguajavaL.): compositional and enzymatic changes, Plant Foods Hum. Nutr. 58 (2003) 309–315.
[42] A. Sharma, V.K. Wali, P. Bakshi, M. Jamwal, Effect of organic manures and biofertilizers on leaf and fruit nutrient status in guava (Psidium guajava L.) cv. Sardar, J. Hortic. Sci. 6 (2) (2011) 169–171.
[43] M.A.M. Sajib, M.M. Hoque, S. Yeasmin, M.H.A. Khatun, Minerals and heavy metals concentration in selected tropical fruit of Bangladesh, Int. Food Res. J. 21 (5) (2014) 1731–1736.
[44] O. Beyhan, M.A. Bozkurt, S.C. Boysal, Determination of macro-micro nutrient contents in dried fruit and leaves and some pomological characteristics of selected feijoagenotypes (feijoa sellowiana berg.) from sakarya provinces in Turkey, J. Anim. Plant Sci. 21 (2) (2011) 250–255.
[45] Í.H.L. Cavalcante, L.F. Cavalcante, F. A. de Oliveira, F. A. R. de Araújo, Yield, nutrient exportation and mineral status of two guava genotype fruit, Cientifica 33 (2) (2005) 165–171.
[46] V. Nour, I. Trandafir, M.E. Ionica, Ascorbic acid, anthocyanins, organic acids and mineral content of some black and red currant cultivars, Fruit 66 (5) (2011) 353–362.
[47] B.S. Dhillon, S.N. Singh, G.S. Kundal, P.P.S. Minhas, Studies on the developmental physiology of guava fruit II Biochemical characters, Punjab Hortic. J. 27 (3–4) (1987) 212–221.
[48] A. Kazankaya, F. Balta, N. Öztürk, F. Sönmez, Mineral composition of Pistacia (Pistacia vera L.) from Siirt Turkey, Asian J. Chem. 20 (3) (2008) 2337–2343.