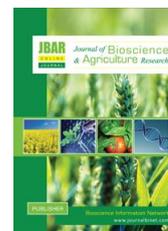


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Morphological Characterization of Guava Germplasm (*Psidium* sp.)

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ABSTRACT

Characterization of germplasm is important for crop improvement. An investigation was carried out with twelve guava germplasm to investigate morphological characters viz. leaf qualitative and fruit qualitative and quantitative characters. The single factor experiment was conducted in randomized complete block design (RCBD) with three replications. Maximum fruit length was found in Chiangmai long (9.37 cm) and minimum was found in Sawadi (4.43 cm). The highest number of seeds was observed in Chiangmai round (352.80). Number of Seed was lesser in Kanchan Nagar (196.40) and in BAU-5 (200.80). Analysis of variance for different characters showed high degree of variation among the germplasm. Among the germplasm BAU-1, BAU-5, Chiangmai long, Chiangmai round, Mukundapuri and Poly guava were found superior according to size, taste, sweetness and so on. The variability in these characters generated valuable information could be used for choice of parents for advance guava breeding programme.

Key Words: Guava morphology, Germplasm characterization, qualitative characters and pulp

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I. Introduction

Guava (*Psidium* sp.) popularly known as the 'poor man's fruit' and the 'apple of the tropics' is a well-known fruit in Indian subcontinent (Nakasone and Paull, 1998). In the Indian subcontinent, it is reported to have been in cultivation since the early 17th century (Mittra and Bose, 1990). It is cultivated in tropical and sub-tropical region for its favorable climate. The most commonly cultivated are the common guava, i.e. *Psidium guajava* L. (Pathak and Ojha, 1993). It is believed to have been originated in the tropical South America. This is cultivated in Hawaii, Cuba, Pakistan and India. Bangladesh is one of the major guava producing countries of the world. It claims to be the most important fruit in respect of area and production after mango, banana, jackfruit, pineapple, and melon in Bangladesh (BBS 2010). It

is popular due to its year-round availability, affordable price, rich nutritional and medicinal value and suitability for transportation, handling and consumer preference.

Guava exemplifies an excellent source of vitamins-C, as well as calcium, phosphorus, iron and zinc (Singh 2005). Hundred grams of guava per capita is sufficient for meeting the daily requirement of vitamin C and iron. Calcium, phosphorus, potassium, sulphur, sodium, chlorine, iron and magnesium are more or less available in guava (FAO 2009). Besides, roots, bark, stems, leaves, flowers and fruits, are used in medicinal uses (Gutierrez *et al.* 2008, Kamath *et al.* 2008). It has low cost cultivation but high economic importance (Rodriguez *et al.* 2010). Variable characters are found in different guava germplasm due to the seedling origin. That's why guava has a great potential for the application of characterization. This will play significant role for further crop improvement. Bangladesh Agricultural University Germplasm Centre (BAU-GPC) has released a good number of guava varieties which has been grown in the country. Moreover, BAU-GPC introduced some guava germplasm from abroad. It is touch stone to a breeder to evolve high yielding varieties through selection from the existing genotypes. The present study was carried out to characterize 12 guava germplasm because of leaf and fruit characters. The experiment was carried out to study the morphological characteristics of guava and to select the superior guava germplasm suitable for commercial cultivation.

II. Materials and Methods

Experimental site, time, soil and treatment: The experiment was carried out at the Germplasm Centre of Fruit Tree Improvement Project (FTIP), Department of Horticulture, Bangladesh Agricultural University, Mymensingh from 2011 to 2012 with 12 germplasm of guava collected from home and abroad. The germplasm are BAU-1, BAU-5, BAU-6, Sawrupkathi, Kanchan Nagar, Brazil, Thai oval, Chiangmai round, Chiangmai long, Poly guava, Mukundapuri and Sayedi. The soil is loam type and belongs to the Old Brahmaputra Flood Plain Alluvial (UNDP 1988). It was a medium high land, fertile, well drained and slightly acidic with soil pH varying from 5.5 to 6.8 and the amount of organic carbon, total N, available P and available K were 0.835%, 0.068, 18 ppm and 0.28 me/100 g of the soil samples, respectively (FAO 1998). The plants of uniform in age and size were established by air layering. Mature leaves and fruits were randomly collected from each selected plant for the study.

Characterization of leaves: Leaf shape, tips and venation were determined by eye estimation, color was by using color chart, upper and lower surface smoothness was estimated by using finger touch and all are expressed in language.

Method used for studying the qualitative characters of fruit: Shape and flesh color of fruit was determined by using a standard chart and eye estimation and expressed in language based on the descriptors for guava developed by IBPGR (1999). Skin color of fruit was determined at full mature stage by comparing with a color chart as greenish yellow, greenish white, whitish, whitish, green, prime rose yellow, light yellow and deep brown. Surface smoothness of fruit of all selected guava germplasm was determined by finger touch and eye estimation method and grouped as moderately smooth, smooth, moderately rough, slightly rough, rough and very rough. Texture of pulp and sweetness/taste of fruit were determined by a panel of judges through organoleptic test. Texture of pulp was expressed in language as medium crispy, crispy, medium soft and soft and sweetness/taste of fruit was expressed in language as fairly sweet, moderately sweet, sweet, very sweet and sour.

Method used for studying the yield contributing characters

Fruit size: The length and diameter of fruits at mature stage for each replication were measured by a scale and a slide calipers respectively and expressed in centimeter (cm).

Number of seeds per fruit: Five fruits at mature stage for each replication were taken and seeds were separated manually and average number of seeds in a fruit was counted.

Weight of seeds per fruit and thousand seeds weight: Then seeds per fruit were weight by an electrical balance and expressed in gram (g). After that thousand seed weight was also recorded.

Weight of seed per hundred gram fruit: The weight of seed and fruit were taken, and then converted into weight of seed per 100g fruit.

Experimental design and Statistical analysis: The single factor experiment was conducted in randomized complete block design (RCBD) with three replications. The ANOVA of the parameters were performed following F-variance test. The significance of the differences of treatment means were evaluated by least significance differences (LSD) test (Gomez and Gomez, 1984) at 5% level of probability.

III. Results and Discussion

Characterization of guava leaves

The shape, color, surface smoothness, venation and tips of leaf of different guava germplasm showed a significant variation among them (Table 01). The shapes found such as long, medium long somewhat ovate and oblong. Long leaves were dominant over other shapes and it were found in the variety of BAU-1, BAU-5, Sawrupkathi, Brazil, Chiangmai round, Chiangmai long and Sayedi where broaden leaves were found in Thai oval, Poly guava and Mukundapuri. Light green leaves were dominant over green, dark green, yellowish green and pinkish. Light green leaves were found in the variety of BAU-5, Sawrupkathi, Kanchan Nagar, Chiangmai long, Mukundapuri and Sayedi. The varieties of Brazil and Thai oval were dark green, yellowish green were found in the variety of BAU-1 and the leaf of Poly guava were pinkish. The upper surface smoothness of the leaves was very smooth, smooth, moderately smooth and rough. Very smooth leaves were found in the variety of Thai oval, rough in BAU-6, Poly guava and Mukundapuri, moderately smooth in Chiangmai round and rest of the variety give the leaves of smooth upper surface. The lower surface was mostly rough. As guava is a dicot plant the common venation was reticulate. The main veins were prominent and about parallel to each other. The tips of the leaves of the variety Mukundapuri were somewhat oblong and the other varieties contain pointed leaf tip.

Table 01. Qualitative characters of guava leaves

Guava Germplasm	Shape of leaf	Smoothness of leaves		Color of leaf	Venation of leaf	Tip of leaf
		Upper surface	Lower surface			
BAU-1	Long	Smooth	Rough	Yellowish green	Reticulate	Pointed
BAU-5	Long	Smooth	Rough	Light green	Reticulate	Pointed
BAU-6	Comparatively Small	Rough	Rough	Green	Reticulate	Pointed
Sawrupkathi	Long	Smooth	Rough	Light green	Reticulate	Pointed
Kanchan Nagar	Somewhat ovate	Smooth	Rough	Light green	Reticulate	Pointed
Brazil	Long	Rough	Rough	Dark green	Reticulate	Pointed
Thai oval	Broaden	Very smooth	Rough	Dark green	Reticulate	Pointed
Chiangmai round	Long	Moderately smooth	Rough	Green	Reticulate	Pointed
Chiangmai long	Long	Smooth	Rough	Light green	Reticulate	Pointed
Poly guava	Broaden	Rough	Rough	Red	Reticulate	Pointed
Mukundapuri	Broaden	Rough	Rough	light green	Reticulate	Oblong
Sayedi	Long	Rough	Rough	Light green	Reticulate	Pointed

Characterization of guava fruits

Fruit size: Highly significant variation was obtained in the fruit length and diameter in different guava germplasm.

Fruit length: Fruit length of different guava germplasm showed a significant variation among them (Figure 01.a) ranging from 4.43 cm to 9.38 cm. The highest fruit length was obtained from Chiangmai long (9.38 cm) followed by BAU-5 (7.83 cm), Chiangmai round (7.13 cm), Poly guava (6.97 cm), BAU-1 (6.95 cm), Thai oval (6.44 cm), Kanchan Nagar (6.23 cm), Mukundapuri (6.10 cm), BAU-6 (5.69 cm),

Sawrupkathi (5.19 cm), Brazil (5.09 cm) and Sayedi (4.43 cm). This variation in fruit length was due to the heretic behavior of the germplasm. Such variations were also reported by [Mitra et al. \(1983\)](#), [Azad et al. \(1987\)](#), [Ullah et al. \(1992\)](#) and [Hossain \(1999\)](#).

Diameter of Fruit: Fruit diameter of different guava germplasm ranged from 4.27 cm to 8.80 cm ([Figure 01.b](#)). The highest fruit diameter was observed in BAU-5 (8.54 cm) and the lowest in Brazil (4.27 cm). The diameter of the rest germplasm were Chiangmai round (8.32 cm), Chiangmai long (7.18 cm), Mukundapuri (6.65 cm), Kanchan Nagar (6.61 cm), Thai oval (6.47 cm), Poly guava (6.34 cm), Sawrupkathi (6.20 cm), BAU-6 (6.17 cm) and BAU-1 (6.04 cm). [Nag \(1998\)](#) recorded that diameter of different fruit varied from 5.87 cm to 7.82 cm. [Azad et al. \(1987\)](#) and [Ullah et al. \(1992\)](#) also recorded the variation of fruit diameter in different guava germplasm. They observed the highest fruit diameter of 9.6 cm and 8.95 cm, respectively, in Kazi Piara which might be attributed to heretic and agro-ecological factors. The present findings are agreement with them.

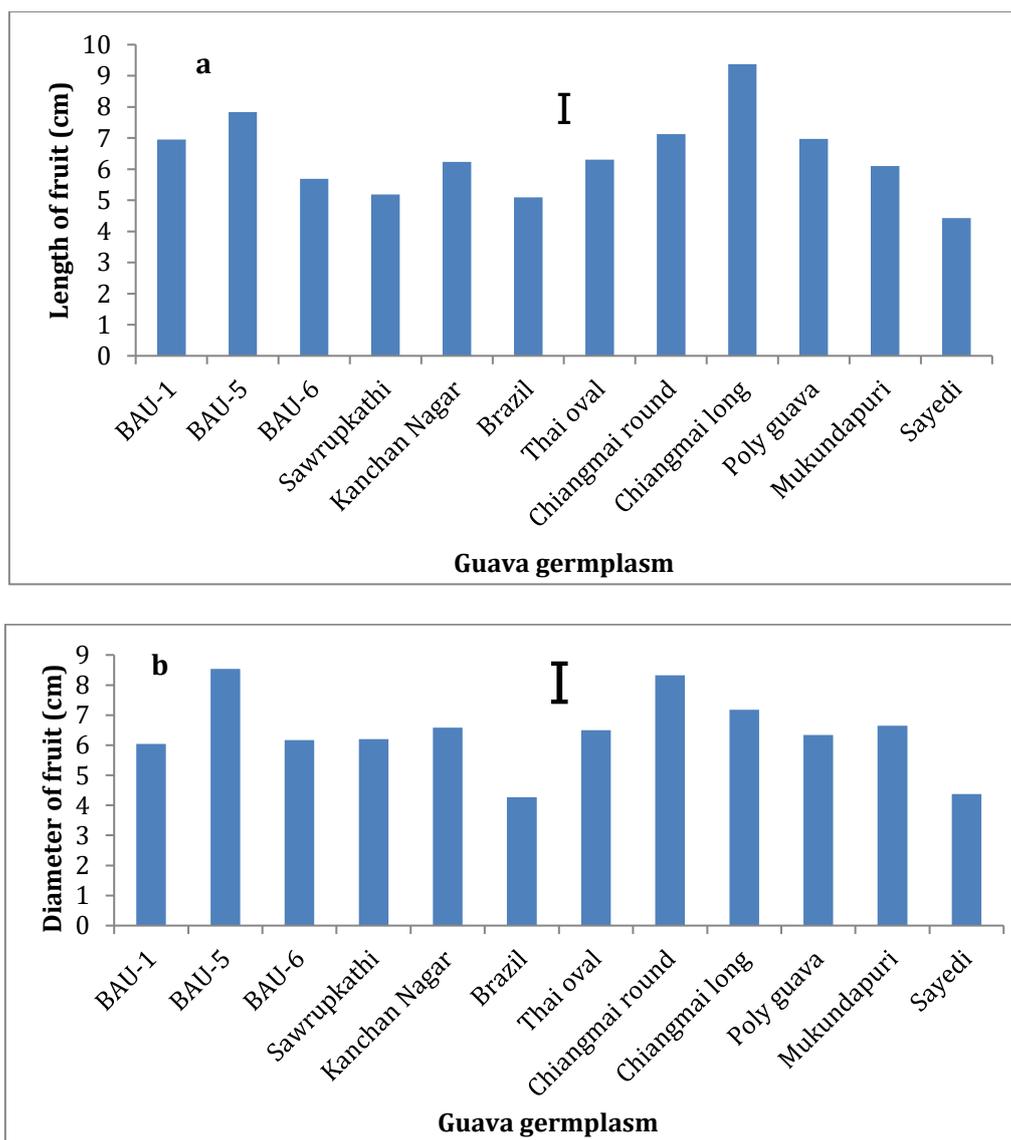


Figure 01. a. Length of fruit and b. Diameter of fruit of different guava germplasm. Vertical bar indicates LSD at 5% level of probability.

Dry weight per 100 g fruits: Significant variation was observed among the germplasm under the study in dry weight of fruits per 100 g ([Figure 02.a](#)). The highest dry weight was obtained from Thai oval (18.14 g) per 100 g fruits followed by Brazil (16.92 g), Poly guava (15.07 g), Mukundapuri (14.25 g), BAU-1 (13.99 g), Sawrupkathi (13.88 g), Sayedi (13.53g), Kanchan Nagar (13.28 g), Chiangmai long (13.13 g), Chiangmai round (12.46g), BAU-5 (12.09 g) and BAU-6 (11.09 g).

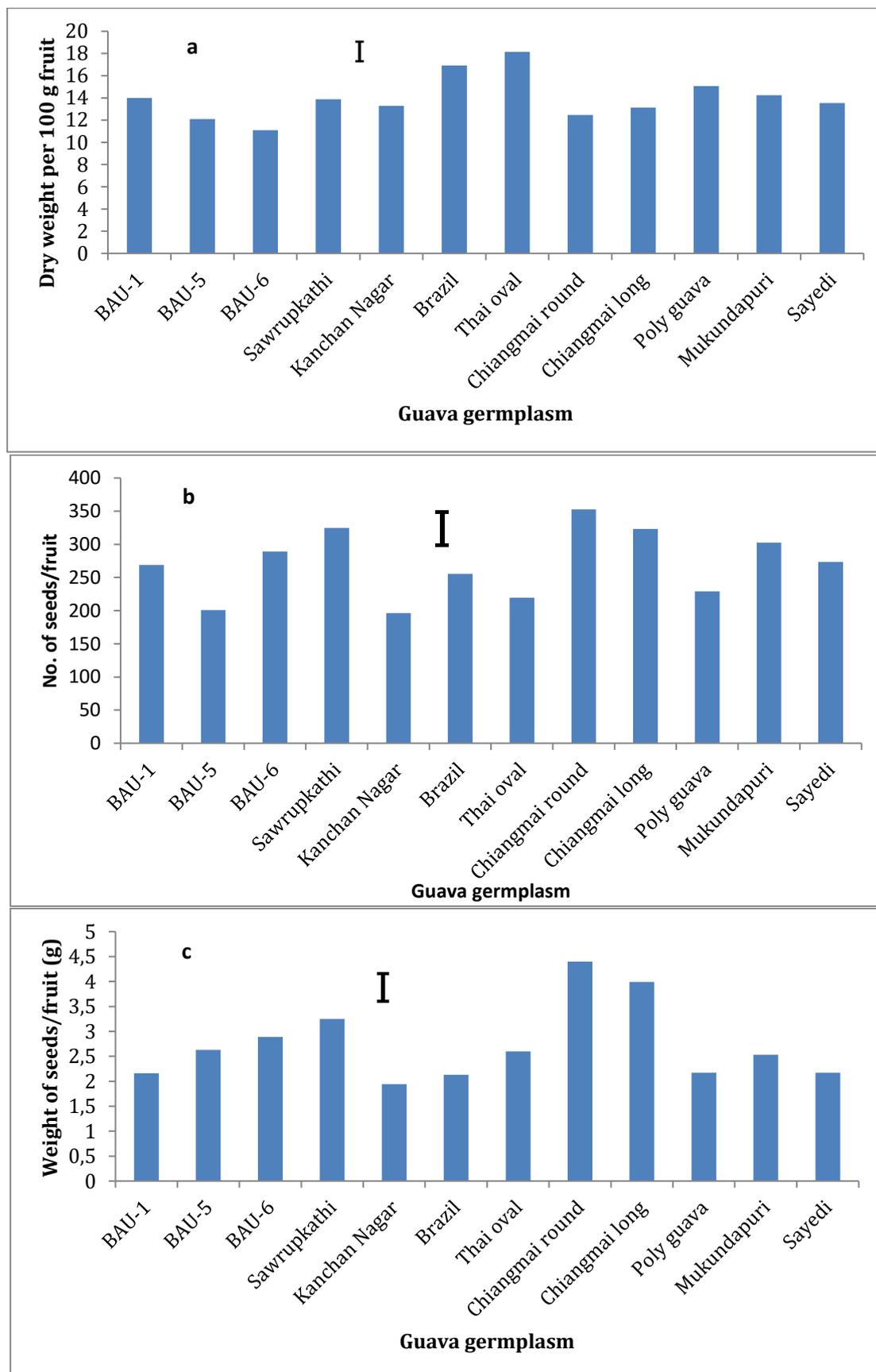


Figure 02. a. Dry weight of 100 g fruit, b. No. of seeds and c. Weight of seeds/fruit of different guava germplasm. Vertical bar indicates LSD at 5% level of probability.

Characteristics of guava seed

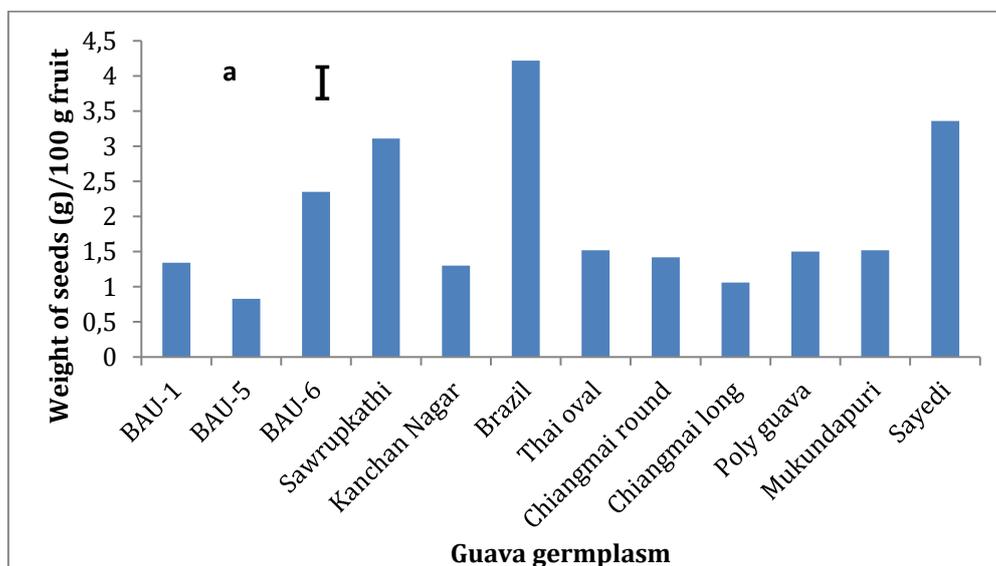
Seeds were collected from mature guava by fermentation method and studied the different characters of seed. A wide range of variation was observed among the seed characters, which are discussed below:

Number of seeds per fruit: It was observed from the result that there was a remarkable variation among the germplasm of guava in number of seeds per fruit (Figure 02.b). Number of seeds per fruit ranged from 196.4 to 352.8. The highest number of seed per fruit was observed in Chiangmai round (352.8) followed by Sawrupkathi (324.8), Chiangmai long (323.33), Mukundapuri (302.53), BAU-6 (289.00), Sayedi (273.37), BAU-1 (268.89), Brazil (255.47), Poly guava (229.20), Thai oval (219.73), BAU-5 (200.80) and Kanchan Nagar (196.40). The number of seeds per fruit is controlled by heretic structure of plant. Shankar (1967), Azad *et al.* (1987), Ullah *et al.* (1992) and Nag (1998) also reported the variation in seed per fruit among different guava varieties.

Weight of seeds per fruit: There was significant variation among the germplasm under study in weight of seeds per fruit (Figure 02.c). Maximum weight of seeds per fruit was obtained from Chiangmai round (4.39 g) which was significantly different from others followed by Chiangmai long (3.99 g), Sawrupkathi (3.25 g), BAU-6 (2.89 g), BAU-5 (2.63 g), Thai oval (2.60 g), Mukundapuri (2.53 g), Brazil (2.19 g), Poly guava (2.17 g), BAU-1 (2.16 g), Sayedi (2.17 g) and Kanchan Nagar (1.94 g). Ullah *et al.* (1992) observed that the weight of seeds per fruit ranged from 1.9 g to 7.5 g, which is not fully supported by the present study.

Weight of seeds per 100 g fruit: The weight of seeds per 100 g fruit varied significantly (Figure 03.a) and the highest weight of seeds per 100 g fruit was found in Brazil (4.22 g) which was significantly different from others, followed by Sayedi (3.36 g), Sawrupkathi (3.11 g), BAU-6 (2.35 g), Mukundapuri (1.52 g) and Thai oval (1.52 g). The lowest weight of seeds per 100 g fruit was found in BAU-5 (0.83 g), followed by Chiangmai round (1.42 g), Chiangmai long (1.06 g), Kanchan Nagar (1.30 g), and BAU-1 (1.34 g). This result was somewhat similar with the findings of Ullah *et al.* (1992) and Hossain (1999) who reported that the highest weight of seeds per 100 g fruit was 3.20 g and 4.14 g respectively.

Weight of 1000 seeds: Weight of seeds per fruit was converted into 1000 seeds weight and presented in figure 03.b. There was a significant variation in weight of 1000 seeds among the germplasm. Thousand seed weight varied from 7.93 g to 13.07 g. Seeds of BAU-5 (13.07 g) produced the heavier seeds followed by Chiangmai round (12.46g), Chiangmai long (12.34 g), Thai oval (11.90 g), BAU-6 (10.15 g), Sawrupkathi (9.96 g), Kanchan Nagar (9.86 g), Poly guava (9.48 g). Sayedi (7.93 g) produced the lighter seeds followed by BAU-1 (8.04 g) and Brazil (8.57 g). It was similar with the findings of Hossain (1999). Differences in seed weight among the varieties were also reported by Azad *et al.* (1987).



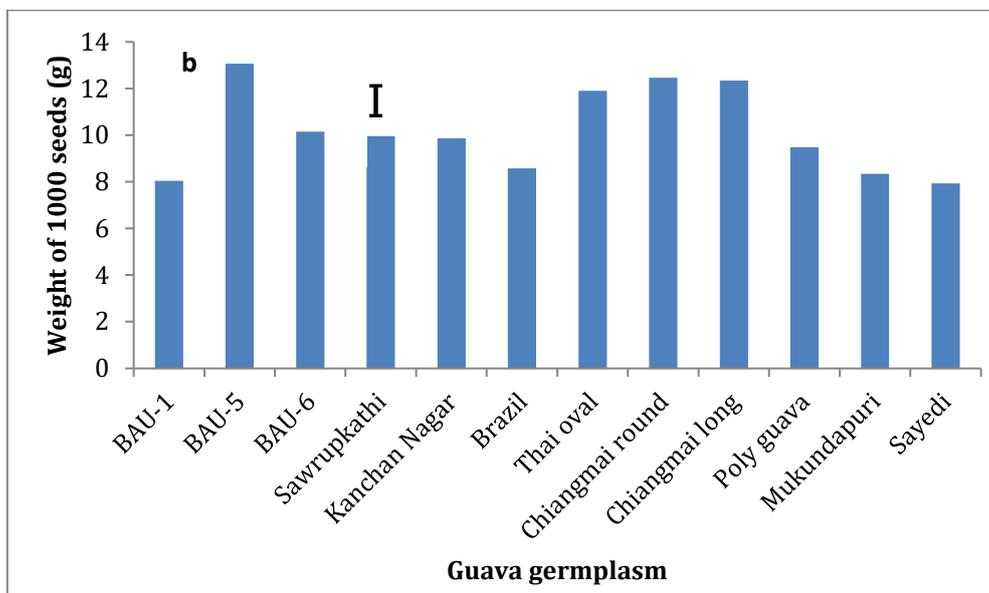


Figure 03.a. Weight of seeds (g)/100 g fruit b. Weight of 1000 seeds of different guava germplasm. Vertical bar indicates LSD at 5% level of probability.

Qualitative characteristics of guava fruits

Matured fruits were collected from 12 germplasm of guava cultivated at FTIP germplasm center and different qualitative characters were observed. The results of different quantities characters like shape of fruits, skin color, surface smoothness, flesh color, texture of pulp and taste of fruits were recorded which are shown in [table 02](#). Five different fruit shapes were recorded and ovate was found to dominate among others ([Table 02](#)). Fruit shape was globose in BAU-5 and Mukundapuri, roundish fruit in Chiangmai round and Poly guava, Ovate in BAU-1, BAU-6, Sawrupkathi and Brazil, pear shape fruits were found in Sayedi and slightly roundish in Chiangmai long. Fruit shapes were controlled genetically and different researches also studies thee fruit shape of different guava germplasm. The present findings are in agreement with [Mitra and Bose \(1990\)](#), [Ullah et al. \(1992\)](#), [Nag \(1998\)](#) and [Hossain \(1999\)](#) and they found wide variation in fruit shape of guava. Those are agreement with the present findings.

Light green color fruits were dominated over others. Skin color of matured guava fruits of BAU-6, were yellowish green Germplasm, BAU-1, Sawrupkathi, Kanchan Nagar, Chiangmai long, Chiangmai round and Sayedi produced fruits of light green in color. Greenish fruits were found in Mukundapuri, greenish yellow in Thai oval and Brazil. The skin color of fruits in Poly guava was reddish brown ([Table 02](#)). The results are in conformity with the findings of [Hossain \(1999\)](#) and [Begum \(1999\)](#) regarding the common varieties they studied. Surface smoothness varied from very rough to smooth. Genotypes Sawrupkathi and Mukundapuri produced very rough surfaces fruits while fruits surface produced by genotypes BAU-1, BAU-5, Kanchan Nagar, Chiangmai long, Chiangmai round and Sayedi smooth to moderately smooth. Rest of the genotypes produced fruits with rough to moderately rough surface ([Table 02](#)). The flesh of the fruits in Brazil was red; BAU-6 was reddish pink in color. Rest of the genotypes produced white to creamy white flesh except Poly guava and Sayedi, which was reddish violet and reddish brown ([Table 02](#)). It was somewhat similar with the findings of [Ullah et al. \(1992\)](#), [Nag \(1998\)](#) and [Hossain \(1999\)](#).

The texture of pulp of the fruits of different genotypes were crispy in BAU-5, Mukundapuri, medium crispy in BAU-1, Sawrupkathi, Thai oval, Kanchan Nagar, Chiangmai round, Chiangmai long, Poly guava and BAU-6, Brazil, Sayedi produced soft textured pulp ([Table 02](#)). The results are in conformity with the findings of [Ullah et al. \(1992\)](#) and [Hossain \(1999\)](#). The taste of fruit categorized as fairly sweet, medium sweet, sweet, very sweet, sour and very sour. The taste of the fruits of BAU-1 and Brazil were very sweet. The genotypes BAU-5, Chiangmai round and Chiangmai long produced medium sweet fruits, Sawrupkathi, Thai oval, Mukundapuri and Sayedi produced sweet fruits but BAU-6 produced fruits of sour in test ([Table 02](#)).

Table 02. Qualitative characteristics of 12 guava germplasm

Sl. No.	Variety	Shape of fruits	Skin color	Surface smoothness	Flesh color	Texture of pulp	Taste of fruits
1	BAU-1	Ovate	Light green	Smooth	White	Medium crispy	Very sweet
2	BAU-5	Globose	Light yellow	Smooth	Whitish	Crispy	Fairly sweet
3	BAU-6(Jelly)	Ovate	Yellowish green	Rough	Reddish pink	Soft	Sour
4	Sawrupkathi	Ovate	Light green	Very rough	Creamy white	Medium crispy	Sweet
5	Thai oval	Pear shaped	Greenish yellow	Rough	White	Medium crispy	Sweet
6	Brazil	Ovate	Yellowish green	Moderately rough	Red	Soft	Very sweet
7	Kanchan Nagar	Pear shaped	Light green	Smooth	White	Medium crispy	Very sweet
8	Chiangmai round	Roundish	Light green	Smooth	White	Medium crispy	Fairly sweet
9	Chiangmai long	Slightly Roundish	Light green	Smooth	White	Medium crispy	Fairly sweet
10	Poly guava	Roundish	Reddish brown	Moderately rough	Reddish violet	Medium crispy	Medium sweet
11	Mukundapuri	Globose	Greenish	Very rough	Creamy white	Crispy	Sweet
12	Sayed	Pear shaped	Light green	Moderately smooth	Reddish brown	Soft	Sweet

IV. Conclusion

A wide range of variation exists among the collected guava germplasm. Leaf characters exhibited variation in terms of shape, color and smoothness. Seed number was lesser in Kanchan nagar and BAU-5. Fruit quality also showed variation in terms of color, shape, surface smoothness, pulp texture and taste. BAU-1, BAU-5, Kanchan nagar, Chingmai round, Chingmai long have smooth surface. BAU-5 and Mukundapuri have crispy pulp texture. These can be used for commercial cultivation. The variabilities could be used for further breeding programme of guava germplasm. The authors recommend further collection of guava germplasm for getting more variability in respect of desired traits.

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