

Morpho-biochemical evaluation of eight Velvet apple (*Diospyros discolor* Willd.) germplasms

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Received : 25.03.20 ; Revised : 23.05.20 ; Accepted: 25.05.20

ABSTRACT

Velvet apple is a neglected underutilized minor fruit of Bangladesh. It is enormously grown in southern coastal areas of the country. They are apparently varied in leaves and fruits. Therefore, this study was undertaken to evaluate morpho-biochemical traits of velvet apple germplasms. This single factor experiment was laid out in randomized complete block design with three replications. Results showed that there were significant variations existed among the germplasms. It was noticed that ACC DD5 exhibited maximum leaf length, width, petiole length, width and leaf area (174.70cm²) whereas those traits were minimum in ACC DD2. It was also observed that ACC DD1, ACC DD2, ACC DD4 and ACC DD7 produced terminal flowering while ACC DD3, ACC DD5, ACC DD6 and ACC DD8 showed axillary. Among the germplasms, larger fruit fresh weight (288.67g), width (8.24cm) was found in ACC DD5 whereas minimum fruit weight (94.30g), width (5.92cm) found in ACC DD2. In terms of fruit length, ACC DD1 produced the highest fruit length (8.69cm) and ACC DD2 gave the lowest (5.74cm). It was also reported that ACC DD5 contained maximum (7.67) and ACC DD4 contained minimum (6.33) number of seeds. The highest seed weight (42.26g), length (3.90cm) and width (1.94) was found in ACC DD3, ACC DD1 and ACC DD5, respectively. However, ACC DD5 contained significantly higher amount of TSS (12.35%Brix), and vitamin C (8.73mg/100g) as compared to other germplasms. The results of the experiment revealed that ACC DD5 exhibited the superior performance whereas ACC DD2 showed the inferior performance among the germplasms.

Keywords: Ascorbic acid (Vitamin C), morphological traits, TSS, Velvet apple

INTRODUCTION

Velvet apple (*Diospyros discolor* Willd.) belongs to the family Ebenaceae is an evergreen, dioecious, important minor tropical fruit. It is native to the Philippine Islands where the common name *mabolo* (Singh, 1998). It is native to the low and average height area of the Philippine Islands from the Island of Luzon to the Southernmost of the Sulu Islands. This is usually cultivated for its fruit and as a shadow tree for road sides. The tree was familiarized into Java and Malaya. In Malaya, it is called *buahmantega* (butter fruit) or *buahsakhlat* or *sagalat* (scarlet fruit). In current times, it has been diminishing in numbers in Malaya. It is only seldom planted in India and mostly as an ornamental because of the charm of the flora and the fruits (Morton, 1987). This plant is also found in Assam, Bihar and Southern parts of India. The fruit is termed in India as peach bloom.

In Bangladesh it is known as *Bilati gab* and is cultivating since many decades. It is sporadically

distributed all over the country and grown well in the district of Kushtia, Jessore, Faridpur, Barisal, Pirozpur, Patuakhali, Barguna and Chattogram Hill Tracts regions. It is very attractive for its beautiful reddish skin color. It is a medium-sized tree growing to a height of 20 m (Das *et al.*, 2010).

Velvet apple is a medium sized to large evergreen tree, grows well in a diversity of soil, from the sea level to the 2,400 ft above sea level. The fruit is nutritious but it is underutilized as human food because of its unpleasant odor comparable to rotten cheese or cat faces and is covered with hair which is irritating to sensitive skin (Pobar, 2013). The edible part of this fruit is flesh but consumption of this fruit is not much common among the people of Bangladesh. Although immature fruits are astringent but ripe fruits are sweet smelling, delicious and are eaten as dessert fruit. It is very tasty and having sandy texture of flesh. It is reported that almost all age groups people like it very much due to its sweet taste and flavor. Currently elite people are interested to eat this fruits as it is still safe for

consumption while other major fruits are reported as adulterated with different health hazardous chemicals. The fruit is an ideal source of calcium, vitamin B, iron, protein, and contains numerous phenolic compounds, terpenoids and flavonoids which are responsible for its antioxidant and antidiabetic activities (Sagar *et al.*, 2010; Pobar, 2013). Studies on chemical constituents have reported the presence of lupeol, maslinic acid, betulin, ursolic acid, taraxerol, lanostane, plumbagin, diospyrin, isoquercetin, glucoside habibone, benzyl butyrate and butyl butyrate (Mallavadhani *et al.*, 1998; Chen *et al.*, 2007; Pino *et al.*, 2008). The major compounds that are detected in peels are butyl-2-methyl butyrate, butanoic acid, 2-methylhexyl ester (Hung *et al.*, 2016). The traditional uses include wounds, diarrhea, dysentery, aphthous stomatitis, snakebites, heart problems, hypertension, spider bites, stomach aches, diabetes and eczema (Ragasa *et al.*, 2009). Besides these, some commercially important chemicals are extracted from leaves, fruits and also from seeds, such as leaf extract yielded alkaloids, reducing sugar, gum, flavonoids and tannins. Tannins are also extracted from fruits and seeds (Lee *et al.*, 2003).

Pharmacological studies showed significant analgesic, anti-inflammatory, antioxidant (Ragasa *et al.*, 2009), anti diarrhoeal and antimicrobial activities (Howlader *et al.*, 2012). Green fruits have medicinal value as the juice of immature fruit is used to cure ulcer and dysentery (Rashid *et al.*, 1987). The juice is also used for the treatment of wounds; oil from seeds is used for diarrhea and dysentery; infusion of fruit is used as gargle for stomatitis (Gani, 1998). Evidences of antioxidant and free radical scavenging properties of *D. discolor* leaves are found in different spectrophotometric assay (Howlader *et al.*, 2012). In Bangladesh, several studies have already been done so far on velvet apple by many researchers (Fakir *et al.*, 2018; Hossain *et al.*, 2015; Howlader *et al.*, 2012; Rahim *et al.*, 2011; Ahmed *et al.*, 2011; Das *et al.*, 2010; Haque *et al.*, 2009). But information on morphological traits of leaves, flowers, fruits, seeds and biochemical constituents of different velvet apple germplasms are still necessary for better understanding on variation among the germplasms. Therefore, this study was

undertaken to evaluate the morphological and biochemical features of eight velvet apple germplasms.

MATERIALS AND METHODS

Experimental site: The experiment was conducted at different locations of Barisal Sadar and Babuganj Upazila of Barisal district (located in between 22°27' and 22°52' north latitudes and in between 90°01' and 90°43' east longitudes) and Dumki Upazila of Patuakhali district (located in between 21°48' and 22°36' north latitudes and in between 90°08' and 90°41' east longitudes) in the year 2018. Eight (8) velvet apple germplasms were included for this study (Table 1). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Samples of leaves, flowers and fruits were collected from each location and carried them to the laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh for characterization. Data were recorded on various leaf characteristics (leaf shape, color, margin, apex, base, length, width, area, petiole length and width), flower traits (bud length, sepal color, length, width, petal color, length, width, pedicel length and flower position), fruit traits (fruit shape, skin color, flesh color, sweetness of flesh, fresh fruit weight, length, width, total soluble solids (TSS), moisture and dry matter content and vitamin C and seed characteristics (seed size, color, number, weight, length and width). Leaf area was determined by using leaf area meter (LI -3100C, LI-COR Bioscience, USA).

Determination of TSS (% Brix): TSS content of velvet apple pulp was determined by using Abbe's Hand refractometer (Atago Co. Ltd., Japan). A drop of velvet apple juice squeezed from fruit pulp on the prism of the refractometer. Percent TSS was obtained from direct reading of the instrument. Temperature corrections were made by using the methods described by Ranganna (1979).

Determination of moisture and dry matter content (%) : Twenty grams (20g) of fruit flesh was taken in an aluminum foil and kept in an electric oven at 80°C for 72 hours until the weight became

constant. Thereafter, the percent moisture content of fruit was calculated using the following formula:

$$\text{Percent moisture content} = \frac{\text{Initial weight (g)} - \text{Final weight (g)}}{\text{Initial weight (g)}} \times 100$$

Determination of vitamin C: It was determined according to the method of Plummer (1971). 6% metaphosphoric acid solution, 10% standard ascorbic acid solution and 2,6 dichlorophenol indophenol solution were used for the determination

Percent dry matter content was calculated using the following formula:

$$\% \text{ dry matter} = 100 - \% \text{ moisture content}$$

of vitamin C. Five ml of aliquot was taken in a conical flask and titrated with dye solution. The vitamin C content was calculated by using the following formula:

$$\text{Ascorbic acid content (mg / 100g)} = \frac{\text{Titre} \times \text{Dye factor} \times \text{Volume made up (ml)}}{\text{Volume of extract (ml)} \times \text{Weight of sample (g)}} \times 100$$

RESULTS

Leaf characteristics

The leaves were observed keenly at the time of recording this parameter. Except color other leaf traits found different among the germplasms. Leaf shape, margin and apex of four germplasms found elliptic oblong, entire and acuminate, respectively while rest were oblong, wavy and acute. The base of leaf recorded as obtuse in single germplasm (Table 2a). The leaf length was ranged from 20.57 cm to 28.27 cm. The maximum value was observed in ACC DD5 (28.27 cm) followed by ACC DD3 and ACC DD1 (28.10 and 27.72 cm), respectively and minimum value (20.57 cm) in ACC DD2 (Table 2b). The leaf width of different velvet apple germplasms was ranged from 7.87 cm to 10.20 cm. The plants of ACC DD5 showed the maximum leaf width (10.20 cm) followed by ACC DD1 and ACC DD7 (9.83 and 9.30 cm), respectively and minimum value (7.87 cm) in ACC DD2 (Table 2b). The petiole length was ranged from 1.13 cm to 1.50 cm. The highest value was observed in both ACC DD1 and ACC DD5 (1.50 cm) followed by ACC DD6 and ACC DD4 (1.47 and 1.43 cm), respectively and the lowest value (1.13 cm) in ACC DD2 and ACC DD8 (Table 2b). It was observed that the leaf area of the germplasms ranged from 115.30 cm² to 174.70 cm². The maximum value of leaf area was found in ACC DD5 (174.70 cm²) followed by ACC DD1 and ACC DD3 (166.25 cm² and 163.11 cm²), respectively and minimum value in ACC DD2 (115.30 cm²) (Fig. 1).

Flower traits

The inflorescence of tested germplasms was observed axillary cymes, solitary or a cluster of three to seven flowers arises from the leaf axil (Plate 1 and Table 3a). Flowers are unisexual, dioecious, incomplete, regular, 3-5 sepals, calyx persistent, 4-5 petals, stamen 3-5 and stigma 4 with superior ovary. The color of sepals was light green and dark green. The color of petals was milky white and white. The position of flower was recorded as terminal and axillary (Plate 1 and Table 3a).

Length of flower buds of eight velvet apple germplasms was ranged from 1.22 cm to 1.72 cm (Table 3b). It was observed that, the accession ACC DD5 gave maximum length of flower buds (1.72 cm) followed by ACC DD6 (1.70 cm), whereas minimum (1.22 cm) was observed in ACC DD1 (Table 3b). Length of sepal ranged from 0.63 cm to 0.87 cm. It was found that, ACC DD6 gave maximum sepal length (0.87 cm) followed by ACC DD5 (0.83 cm), whereas minimum (0.63 cm) was observed in both ACC DD2 and ACC DD3 (Table 3b). Width of sepals was ranged from 0.53 cm to 0.70 cm. It was found that ACC DD1 gave maximum sepal width (0.70 cm) followed by ACC DD3, ACC DD4 and ACC DD8 (0.67 cm), whereas minimum (0.53 cm) was observed in ACC DD6 (Table 3b). Length of petals ranged from 1.23 cm to 2.03 cm. It was observed that ACC DD5 gave maximum petal length (2.03 cm) followed by ACC DD7 (1.57 cm), whereas minimum (1.23 cm) was observed in ACC DD3 (Table 3b). Width of

Table 1: Number and sources of eight velvet apple germplasms

Treatment	Accession number	Sources
T ₁	ACC DD1	Barisal Sadar, Barisal
T ₂	ACC DD2	Babuganj, Barisal
T ₃	ACC DD3	Babuganj, Barisal
T ₄	ACC DD4	Barisal Sadar, Barisal
T ₅	ACC DD5	Barisal Sadar, Barisal
T ₆	ACC DD6	Babuganj, Barisal
T ₇	ACC DD7	Dumki, Patuakhali
T ₈	ACC DD8	Babuganj, Barisal

Table 2a: Leaf characteristics of different velvet apple germplasms

Germplasm	Leaf				
	Shape	Color	Margin	Apex	Base
ACC DD1	Elliptic oblong	Green	Entire	Acuminate	Almost rounded
ACC DD2	Elliptic oblong	Green	Entire	Acute	Almost rounded
ACC DD3	Elliptic oblong	Green	Entire	Acuminate	Almost rounded
ACC DD4	Oblong	Green	Wavy	Acute	Almost rounded
ACC DD5	Oblong	Green	Wavy	Acute	Almost rounded
ACC DD6	Oblong	Green	Entire	Acuminate	Almost rounded
ACC DD7	Oblong	Green	Wavy	Acuminate	Almost rounded
ACC DD8	Elliptic oblong	Green	Wavy	Acute	Obtuse

Table 2b: Leaf characteristics of different velvet apple germplasms

Germplasm	Leaf length (cm)	Leaf width (cm)	Petiole length (cm)	Petiole width (cm)
ACC DD1	27.73	9.83	1.50	0.39
ACC DD2	20.57	7.87	1.13	0.31
ACC DD3	28.10	8.63	1.33	0.36
ACC DD4	23.27	8.07	1.43	0.34
ACC DD5	28.27	10.20	1.50	0.41
ACC DD6	25.10	9.20	1.47	0.38
ACC DD7	26.30	9.30	1.40	0.33
ACC DD8	26.83	6.53	1.13	0.40
LSD _{0.05}	0.55	0.25	0.27	0.02
LSD _{0.01}	0.76	0.35	0.37	0.02
Level of signi	**	**	*	**

* & ** indicates significant at 5% and 1% levels of probability

petals ranged from 0.51 cm to 0.56 cm. It was found that ACC DD5 gave maximum width of petals (0.56 cm) followed by both ACC DD4 and ACC DD8 (0.54 cm), whereas minimum (0.51 cm) was observed in ACC DD7 (Table 3b). Length of pedicels was ranged from 0.10 cm to 0.17 cm. It was found that ACC DD2, ACC DD4 and ACC

DD5 gave maximum length of pedicels (0.17 cm) followed by ACC DD1, ACC DD3, ACC DD7 and ACC DD8 (0.13 cm), whereas minimum (0.10 cm) was observed in ACC DD6 (Table 3b).

Fruit traits

The shapes of fruits were classified as globose, elongate, almost round and it was recorded by visual

Table 3a: Flower characteristics of different velvet apple germplasms

Germplasm	Sepal color	Petal color	Flower position
ACC DD1	Dark green	Creamy white	Terminal
ACC DD2	Dark green	Creamy white	Terminal
ACC DD3	Dark green	Creamy white	Axillary
ACC DD4	Light green	White	Terminal
ACC DD5	Light green	Creamy white	Axillary
ACC DD6	Light green	White	Axillary
ACC DD7	Light green	Creamy white	Terminal
ACC DD8	Light green	Creamy white	Axillary

Table 3b: Flower characteristics of different velvet apple germplasms

Germplasm	Bud length (cm)	Sepal length (cm)	Sepal width (cm)	Petal length (cm)	Petal width (cm)	Pedicle length (cm)
ACC DD1	1.22	0.77	0.70	1.47	0.53	0.13
ACC DD2	1.67	0.63	0.57	1.27	0.52	0.17
ACC DD3	1.33	0.63	0.67	1.23	0.52	0.13
ACC DD4	1.48	0.80	0.67	1.37	0.54	0.17
ACC DD5	1.72	0.83	0.60	2.03	0.56	0.17
ACC DD6	1.70	0.87	0.53	1.37	0.49	0.10
ACC DD7	1.52	0.77	0.63	1.57	0.51	0.13
ACC DD8	1.25	0.77	0.67	1.37	0.54	0.13
LSD _{0.05}	0.11	0.08	0.06	0.16	0.010	0.10
LSD _{0.01}	0.15	0.11	0.08	0.22	0.013	0.13
Level of signi.	**	**	**	**	**	NS

**indicates significant at 1% level of probability, NS indicates not significant

Table 4a: Fruit characteristics of different velvet apple germplasms

Germplasm	Shape	Skin color	Color of flesh	Sweetness of flesh
ACC DD1	Elongate	Reddish brown	White	Medium sweet
ACC DD2	Elongate	Reddish brown	Creamy white	Very sweet
ACC DD3	Almost round	Brown	Creamy white	Very sweet
ACC DD4	Elongate	Reddish brown	Creamy white	Medium sweet
ACC DD5	Almost round	Reddish brown	Creamy white	Very sweet
ACC DD6	Globose	Reddish brown	Creamy white	Very sweet
ACC DD7	Almost round	Reddish brown	Creamy white	Very sweet
ACC DD8	Almost round	Reddish brown	White	Sweet

observation (Plate 2 and Table 4a). The color of skin was found as reddish brown or brown while fruit flesh color was white, creamy white. The responses of panel judge on sweetness of fruit flesh were noticed as very sweet, medium sweet and sweet (Table 4a). Fresh fruit weight was ranged from 94.30 g to 288.67 g. The fruit of ACC DD5

was the heaviest (288.67 g) followed by ACC DD6 (150.46 g). On the other hand, the lightest (94.30 g) fruit was recorded in ACC DD2 (Fig. 2). Length of fruits was ranged from 5.74 cm to 8.69 cm. It was observed that ACC DD1 gave maximum length of fruits (8.69 cm) followed by ACC DD5 (8.01 cm), whereas minimum (5.74 cm) was observed in

Table 4b: Fruit characteristics of different velvet apple germplasms

Germplasm	Fruit length (cm)	Fruit width (cm)	Moisture (%)	Dry matter (%)
ACC DD1	8.69	6.75	77.84	22.16
ACC DD2	5.74	5.92	81.94	18.06
ACC DD3	7.42	6.52	80.88	19.12
ACC DD4	6.71	6.68	82.54	17.46
ACC DD5	8.01	8.24	82.13	17.87
ACC DD6	7.73	6.63	78.50	21.50
ACC DD7	7.46	6.53	79.35	20.65
ACC DD8	6.98	6.11	80.06	19.94
LSD _{0.05}	0.31	0.18	0.51	0.54
LSD _{0.01}	0.43	0.25	0.71	0.75
Level of signi.	**	**	**	**

**indicates significant at 1% level of probability

Table 5: Seed characteristics of different velvet apple germplasms

Germplasm	Seed size	Seed color	No. of seeds per fruit	Seed length (cm)	Seed width (cm)	Seed weight (g)
ACC DD1	Large	Dark brown	7.67	3.90	1.73	33.47
ACC DD2	Medium	Dark brown	7.33	3.23	1.60	20.95
ACC DD3	Large	Light brown	7.00	3.82	1.78	42.26
ACC DD4	Large	Dark brown	6.33	3.65	1.74	27.87
ACC DD5	Large	Light brown	7.67	3.80	1.94	35.85
ACC DD6	Large	Dark brown	7.33	3.71	1.77	40.94
ACC DD7	Large	Light brown	7.00	3.75	1.87	36.73
ACC DD8	Medium	Light brown	7.67	3.26	1.64	37.39
LSD _{0.05}			0.84	0.21	0.08	0.25
LSD _{0.01}			1.17	0.30	0.11	0.35
Level of signi.			*	**	**	**

* & ** indicates significant at 5% and 1% levels of probability

ACC DD2 (Table 4b). The width of fruits was ranged from 5.92 cm to 8.24 cm. It was found that ACC DD5 gave maximum width of fruits (8.24 cm) followed by ACC DD1 (6.75 cm), whereas minimum (5.92 cm) was observed in ACC DD2 (Table 4b).

Seed traits

The size of the seeds was classified as medium and large with dark brown and light brown in color (Plate 3 and Table 5). Number of seeds was ranged from 5 to 8 with a mean value 6.33 to 7.67. The number of seeds of ACC DD1, ACC DD5 and ACC DD8 was the highest (7.67) followed by both ACC DD2 and ACC DD6 (7.33). On the other hand, the lowest (6.33) number of seeds was

recorded in ACC DD2 (Table 5). Seed weight was ranged from 20.95 g to 42.26 g. Seed weight of ACC DD3 was the highest (42.36 g) followed by ACC DD6 (40.94 g). On the other hand, the lowest (20.95 g) seed weight was recorded in ACC DD2 (Table 5). Length of seeds was ranged from 3.23 cm to 3.90 cm. It was observed that ACC DD1 produced maximum length of seeds (3.90 cm) followed by ACC DD3 (3.82 cm), whereas minimum (3.23 cm) was observed in ACC DD2 (Table 5). The width of seeds was ranged from 1.60 cm to 1.94 cm. It was observed that ACC DD5 produced maximum width of seeds (1.94 cm) followed by ACC DD7 (1.87 cm), whereas

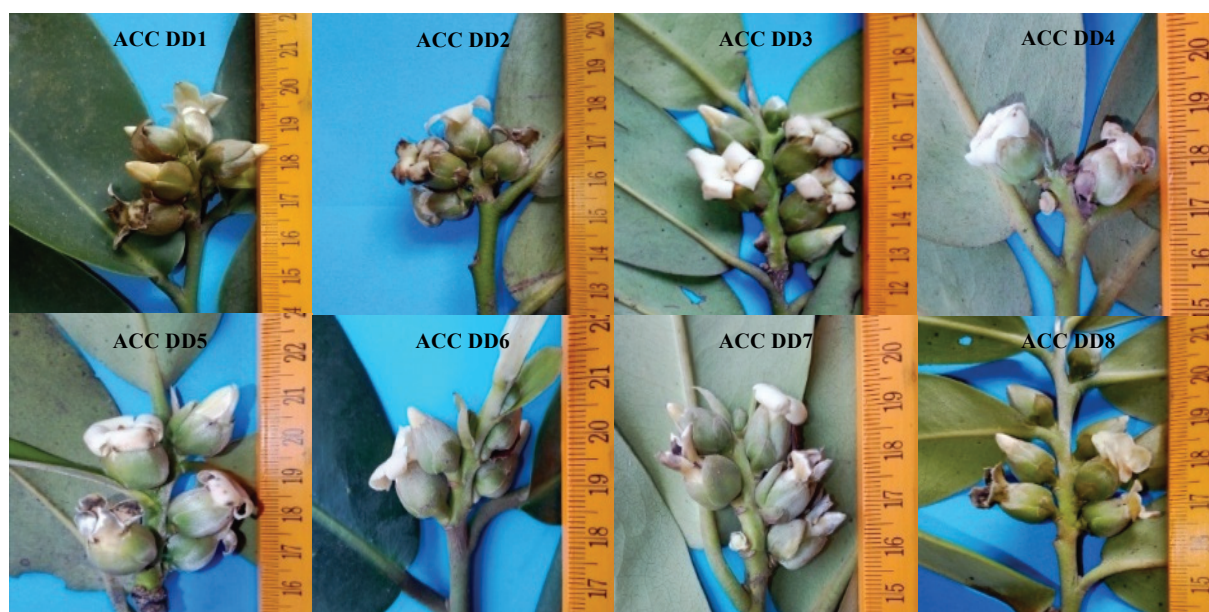


Plate 1: Flower shape and position of velvet apple germplasms

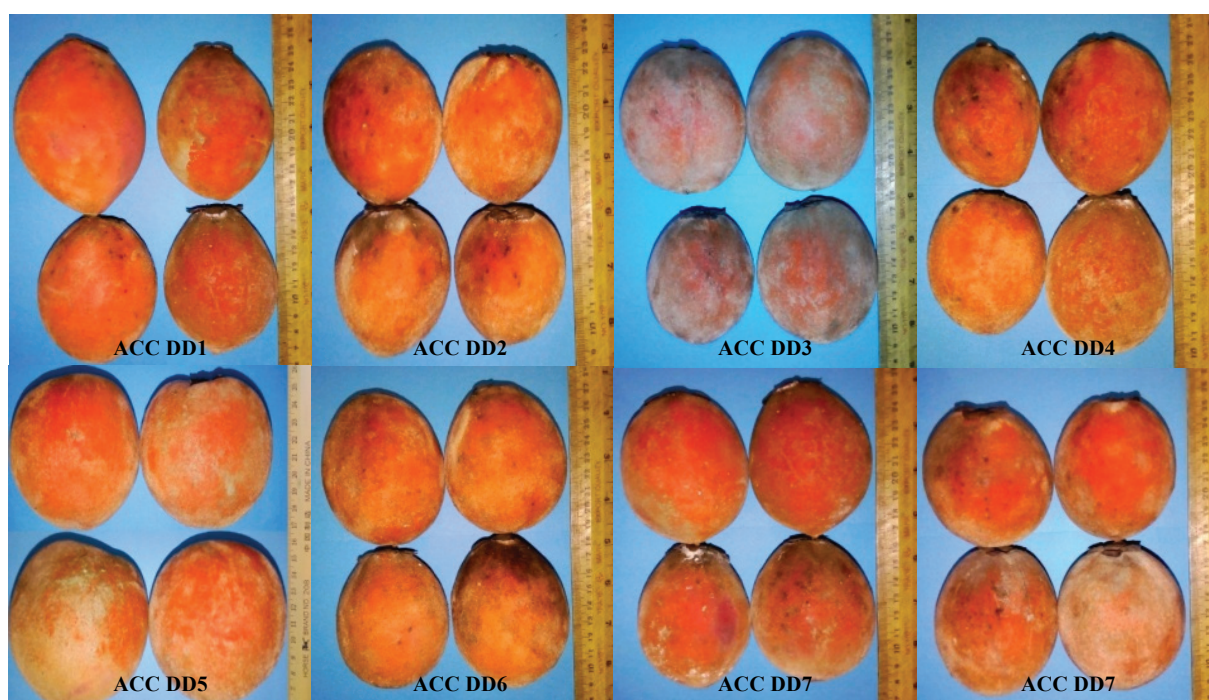


Plate 2: Fruit size and shape of velvet apple germplasms

minimum (1.60 cm) was observed in ACC DD2 (Table 5).

Biochemical traits

Total soluble solids (TSS) percentage is one of the important parameter that determines the quality of fruits. The percentage of TSS of velvet apple was ranged from 10.08 to 12.35%Brix (Fig. 3). It

was found that fruits of ACC DD5 had the highest percentage of TSS (12.35%Brix) followed by ACC DD7 (11.95%Brix), while it was the lowest (10.08%Brix) in ACC DD2 (Fig. 3). The percentage of moisture content of velvet apple was ranged from 77.84 to 82.54%. It was found that fruits of ACC DD4 had the highest percentage of moisture content

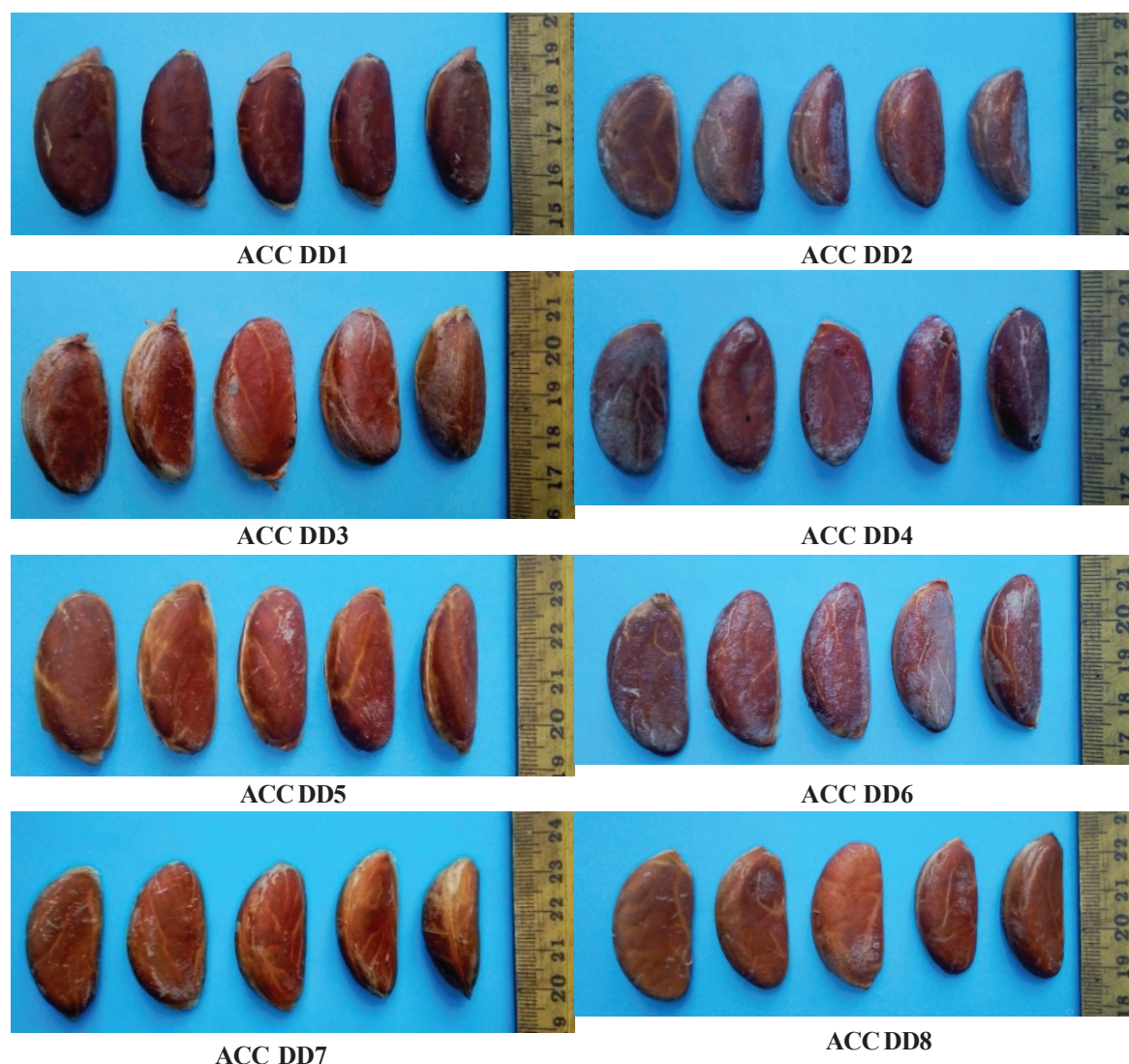


Plate 3 : Seed size and seed shape of velvet apple germplasms

(82.54%) followed by ACC DD5 (82.13%), while it was the lowest (77.84%) in ACC DD1 (Table 4b). The percentage of dry matter content of velvet apple was ranged from 17.46 to 22.16%. It was observed that fruits of ACC DD1 had the highest percentage of dry matter content (22.16%) followed by ACC DD6 (21.50%), while it was lowest (17.46%) in ACC DD4 (Table 4b). The highest amount of vitamin C was found in ACC DD8 (8.75 mg/100g) and the lowest was found in ACC DD2 (4.36 mg/100g) (Fig. 4).

DISCUSSION

Minor fruits are rich sources of vitamins, minerals and antioxidants. It also has enormous medicinal value. Velvet apple is one of the important

minor fruit in Bangladesh. This study was carried out to evaluate morpho-biochemical traits of different velvet apple germplasms. In this study, each individual character showed significant difference among the selected germplasms. The variations on various morphological and biochemical characters may vary due to the influences of soil nutrients, climate, rainfalls, age of plants and harvesting maturity. However, morphological features of leaves found significantly different among the selected germplasms. Lim (2012) reported that the leaf length of velvet apple ranges from 8-30 cm and the leaf width ranges from 2.5-12 cm. In this study we noticed that leaf length and width ranges from 20.57 cm to 28.27 cm and 6.53 cm to 10.20 cm, respectively. Hossain *et al.* (2015) reported that

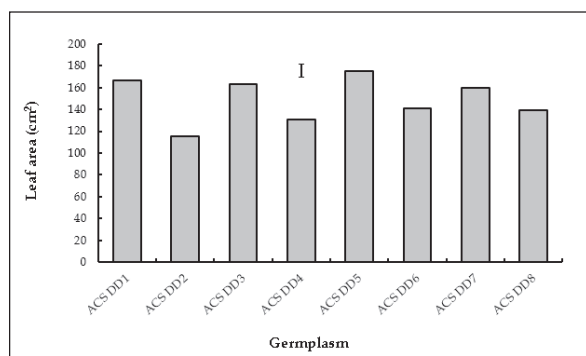


Fig. 1: Leaf area of velvet apple germplasms. Vertical bar represents LSD at 1% level of significance

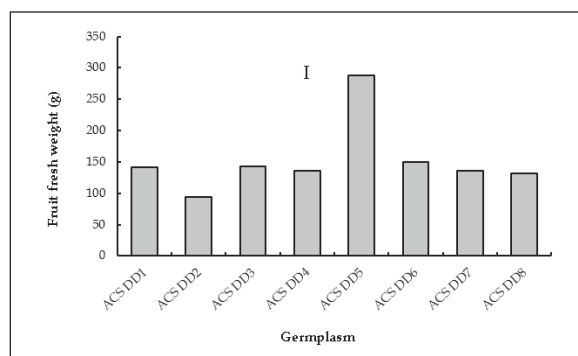


Fig. 2: Fruit fresh weight of velvet apple germplasms. Vertical bar represents LSD at 1% level of significance

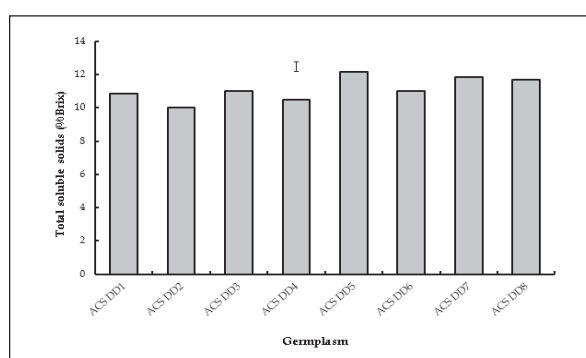


Fig. 3: Total soluble solids (TSS) of velvet apple germplasms. Vertical bar represents LSD at 1% level of significance

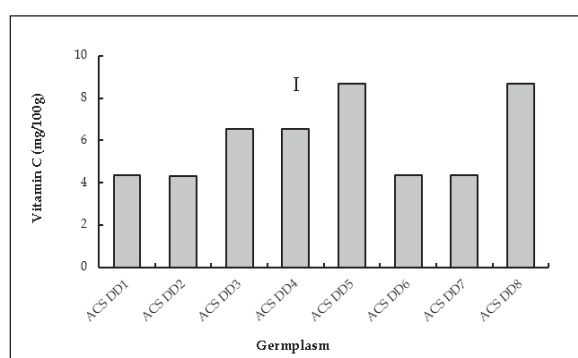


Fig. 4: Vitamin C content of velvet apple germplasms. Vertical bar represents LSD at 1% level of significance

leaf area of velvet apple germplasms varied from 150.00 cm² to 157.80 cm². We observed that leaf area of velvet apple germplasms varied from 115.30 cm² to 174.70 cm². We noticed that flowers of tested velvet apple germplasms are unisexual. Fakir *et al.*, (2018) also reported that flowers of velvet apple are incomplete and multicarpellary ovary. Fruit traits were also varied among the tested germplasms, the result of this study was partially supported by the findings of Chong *et al.* (2009). They reported that, the fruit length of velvet apple ranges from 5-12 cm and the fruit width ranges from 8-10 cm. However, seed traits were also significantly varied among the tested germplasms. The highest average number of seeds was obtained from ACC DD1, ACC DD5 and ACC DD8 (7.67) whereas minimum was in ACC DD4 (6.33), which was similar to the findings of Rahim *et al.* (2011). They reported that the number of seeds of velvet

apple were ranges from 1-8. The length and width of seeds was varied significantly due to the accessions. Maximum seed length (3.90cm) and seed width (1.94cm) was observed in ACC DD1 and ACC DD5, respectively. Minimum seed length and seed width was observed in ACC DD2 (3.23cm and 1.60cm, respectively). Similar findings were reported by Chong *et al.* (2009). They noticed that the seeds of velvet apple are 4 cm long and 2.5 cm wide.

It was found that fruits of ACC DD5 had the highest percentage of total soluble solids (12.35%), while it was the lowest (10.08%) in ACC DD2. This result was partially similar to the findings of Haque *et al.* (2009). They conducted an experiment on velvet apple and found that, the TSS content of velvet apple was 13.2%. The percentage of total soluble solids of velvet apple varied significantly due to the influence of different accessions. The increasing amount of TSS may be due to the

degradation of starch and organic acids into soluble sugars.

CONCLUSIONS

From the findings of this study it was found that accession ACC DD5 to be the best in respective of various traits of leaves, flowers, fruits and seeds. Accession ACC DD1 showed the best result in fruit length and found to be the best in case of seed characteristics. The results of the experiment revealed that ACC DD5 exhibited the superior performance whereas ACC DD2 showed the inferior performance among the tested velvet apple germplasms.

ACKNOWLEDGEMENTS

The authors like to express their profound gratefulness to the authorities of Bangladesh Agricultural Research Council (BARC), Dhaka, Bangladesh, for their financial assistance from National Agricultural Technology Program-Phase II Project (NATP-2) under CRG sub project throughout the research work. The authors also extend their cordial thanks to the laboratory staffs of the Department of Horticulture, Professor Muhammed Hossain Central Laboratory and Laboratory of Biochemistry and Molecular Biology, Bangladesh Agricultural University, Mymensingh for their support in conducting the research.

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