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ORIGINAL RESEARCH ARTICLE

Chemical properties and shelf life of velvet apple germplasm

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ABSTRACT

The study was undertaken to evaluate bio-chemical properties, shelf-life determination and expansion of ripe fruits of four velvet apple germplasm. The selected germplasm were local red variety, local yellow variety, PSTU Bilati gab-1 and PSTU Bilati gab-2. Ripe fruits were collected from Germplasm Center, Patuakhali Science and Technology University (PSTU) and different locations of Patuakhali district of Bangladesh. Results expressed that maximum TSS (13.93%), vitamin-C (3.68 mg/100g), non-reducing sugar (5.15%) and total sugar (7.95%) were recorded from PSTU Bilati gab-2, the highest TA (1.30%) was found in PSTU Bilati gab-1 but highest pulp pH (7.50) and TSS to TA ratio (11.11) were recorded from local yellow variety whereas highest reducing sugar (3.17%) was recorded from local red variety. The shelf life of ripe fruit varied from 3.25 – 4.75 days where the longest shelf life was obtained from PSTU Bilati gab-2 and the shortest shelf life was recorded in local red variety. But the storability was extended more than 27 days when stored in "Refrigerator" followed by "Non-perforated poly-bag (NPP)" (10 days), perforated polybag (8 days) and paper bag (6 days). The firmness of fruits were decreased gradually with days but the reduction was minimized when stored in different storage condition where more firmness hold in refrigerator treatment followed by NPP. Similarly, the weight loss was controlled in refrigerator followed by NPP treatment. The results of the experiments revealed that PSTU Bilati gab-2 provides superior chemical properties among the germplasm and 'Refrigerator' treatment exhibited best performance among other.

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INTRODUCTION

Diospyros discolor Wild., a tree in the Ebenaceae family, commonly known as the velvet apple (Greuter, 2000). It is referred to as a dioecious, has many branches, grows to a height of 7–32 m, and has a stout trunk that is dark brown to black with a furrow that is 50–80 cm in diameter and a cone-shaped crown. It is acquainted with some terms, including "Mabolo," "Butter Fruit," "Camogan Ebony," and "Velvet Persimmon," whereas in Bangladesh is named as "Bilati Gab" (Lim, 2012). It originates primarily from the Philippines (Singh, 1998), but particularly native there in low and middle-altitude regions that were then introduced to Java, Malaysia, and India before spreading over all tropical areas (Lim, 2012). It can be found primarily in Assam, Bihar, and the southern region of India. It has been expanding in Bangladesh for many years, but largely grown in the district of Kustia, Jashore, Faridpur, Rajshahi, Barishal, Pirozpur, and Chittagong Hill Tracts region (Ahmed *et al.*, 2011).

Typically, velvet apple contains 84.4% moisture. Yadav *et al.* (2018) revealed that per 100 g of velvet apple contains Calories

62 Kcal, Carbohydrate 13.8 g, Dietary fiber 3.2 g, Crude protein 0.4 g, Crude fat 0.6 g, Glucose 1.9 g, Fructose 2.4 g, Vitamin C 2.2 mg, Vitamin E 0.59 mg, Vitamin B2 0.075 mg, Vitamin B3 0.157 mg, folic acid 0.623 mg, Pantothenic acid 0.19 mg, Choline chloride 62.52 mg, Malic acid 227.1 mg, Fumaric acid 4.5 mg, Zinc 3.6 mg, and Tannin acid 69.2 mg. Velvet apple having pH 5.02±0.45. It contains bio-chemicals per 100g are total sugar 3.81±0.26 g where the reducing sugar content is 2.12±0.11 g and non-reducing sugar is 1.69±0.26 g, total soluble solid (TSS) 11.3^0 Brix and TA 0.46±0.20 g. Each of 100 g dried velvet apple conceive of macro mineral 38.84±6.34 mg Ca, 22.50±2.29 mg Na, 238.51±24.94 mg K, and 32.45±3.15 mg Mg, moreover among the micro minerals- Fe are 1.61±0.62 mg and Zn are 0.54±0.23 mg. A record on total phenolics of fresh matter (FM) (504 ± 23 mg GAE/100 g), total phenolics of dry matter (DM) (3182 ± 146 mg GAE/100 g), total flavonoids of FM (320 ± 11 mg CE/100 g), total flavonoids of DM (2022 ± 68 mg CE/100 g) and the % inhibition of β-carotene bleaching of velvet apple is 60 ± 7 (Recuenco *et al.*, 2016).

As phytochemicals a new flavonol, 7,4'-dihydroxy-5,3',5'-trimethoxyflavonol, five known flavonoids such as (+)-epicatechin, kaempferol, astragalin, hyperin and isoquercitrin and also seven known triterpenes like stigmast-4-en-3-one, mixture of β-sitosterol and stigmasterol, β-sitosterol-3-O-glucopyranoside, betulin, betulinic acid as well as ursolic acid are identified from velvet apple leaves and stem (Somat *et al.*, 2020). Antioxidant activity in bark showed highest IC_{50} value of 45.78 µg/ml that is followed by the fruit (69.13 µg/ml) and leaf (72.50 µg/ml). The amount of total phenolic content varied in different extractives, range from 5.65 mg of GAE /g of extractives to 9.16 mg of GAE / g of extractives. The highest phenolic (9.16 mg of GAE /g of extractives) content presents in bark followed by fruit (5.95 mg of GAE / g of extractives) and leaves (5.65 mg of GAE / g of extractives) (Das *et al.*, 2010). The traditional use of velvet apple included treatment of wounds, snakebites, spider bites, stomachache, diabetes, heart problems, hypertension, dysentery, diarrhea and eczema (Somat *et al.*, 2020). It is a source of several commercially significant chemicals that are extracted from leaves, fruits, and seeds. For example, leaf extract produces alkaloids, reducing sugar, flavonoids, and molecules that resemble tannins. In addition to this, fruits and seeds are also used to extract tannins (Lee *et al.*, 2003).

Previous studies of velvet apple mostly conducted on different morphological characteristics of plant, leaf, flower, fruit and seed, and different bio-chemical properties. But postharvest studies like determination of bio-chemical properties, shelf life and extension of shelf life have not performed yet. Therefore, this study was undertaken to determine the attributes of different velvet apple germplasm.

MATERIALS AND METHODS

Experimental sample and design

The research were conducted at Post-harvest laboratory, Patuakhali Science and Technology University during the year 2021. Fruits of four velvet apple germplasm of local red variety (G1), local yellow variety (G2), PSTU Bilati gab-1 (G3) and PSTU Bilati gab-2 (G4) were collected from different location of Patuakhali district, Bangladesh. For chemical analysis the experiment was laid out in Randomized complete Block Design (RCBD) with four replications and the layout for different storage technique was designed in Completely Randomized Design (CRD). Data were collected following the descriptor of Ebenaceae family and collected data were analyzed using JMP 14 computer program.

Determination of moisture and dry matter content

Twenty grams (20 g) of fruit flesh was taken in an aluminum foil and kept in electric oven at 80°C for 72 hours until the weight became constant (Haque *et al.*, 2020). The following formula were used:

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

Dry matter (%) = 100 - Moisture content (%)

Determination of titratable acidity (TA)

It was determined according to the method by Ranganna (1979). Whatman filter paper No.2. 1% phenolphthalein, 0.1 N sodium hydroxide (NaOH). The titer volume was recorded and the result was expressed as percentage citric acid, which was calculated using the following formula:

$$\text{Titratable acidity (\%)} = \frac{\text{Titre (ml)} \times \text{NaOH (0.1 N)} \times \text{Vol.made up} \times \text{Citric acid eq.wt.(64 g)}}{\text{volume of sample for titrate (5 ml)} \times \text{weight of sample taken (10 g)} \times 1000} \times 100$$

Determination of total soluble solids (TSS)

The TSS (^{0}Brix) of velvet apple pulp was determined by using a digital refractrometer (BOECO, Germany). One drop of the filtrate was placed on the prism glass of the refractrometer to get the original TSS reading. Percent TSS was recorded from direct reading of the instrument. Temperature correction was made by using the methods by Ranganna (1979).

Determination of pH

The pH of velvet apple pulp was measured using the glass electrode pH meter (GLP 21, Crison, Bercelona, and EEC). The pH meter was calibrated with the buffers at pH 4.0 followed by pH 7.0. After that, the glass electrode was placed into the filtrate to measure the pH and stabilized reading was recorded.

Ascorbic acid (Vitamin C) content

It was determined according to the method of Ranganna (1979). 3% cold metaphosphoric acid (HPO_3); Whatman filter paper no. 2; 2, 6-dichlorophenol-indophenol solution and 10% standard ascorbic solution were used for determining vitamin-C. 5ml of aliquot was taken in a conical flask and titrated with dye solution. The titre volume was noted and ascorbic acid content was calculated using the following formula:

$$\text{Vitamin C (mg/100g)} = \frac{\text{Titre (ml)} \times \text{dye factor} \times \text{vol.made up (50 ml)}}{\text{Aliquot used for estimation (5 ml)} \times \text{sample weight (10 g)}} \times 100$$

Sugar content

Sugar content of fruit pulp was determined to the method of Lane and Etymon (1923). The reagents used for the estimation of reducing, non-reducing and total sugar were as follows: Fehling's solution (A), Fehling's solution (B), Methylene blue indicator, Forty five percent neutral lead acetate solution, Twenty two percent potassium oxalate solution. Both Reducing sugar and total invert sugar content was calculated by the following formula:

$$\text{Reducing sugar/total invert sugar content (\%)} = \frac{\text{Fehling's factor} \times \text{Dilution} \times 100}{\text{Titre} \times \text{Weight or volume of the sample} \times 100}$$

Percentage of non-reducing sugar (%) = % total invert sugar - % reducing sugar

Shelf life

Five storage treatments viz. open tray, paper bag, perforated polybag, non-perforated polybag and refrigerator (4°C) were used to determine shelf life and postharvest loss of velvet apple. Four germplasm were used in those treatments with four replications. For this purposes, fully ripe fruits were harvested from plants for confirming uniform physical condition of fruits. Except refrigerator, other four treatment were set at 28.5°C temperature with 75% relative humidity. The samples of each treatment observed at every two days and data according to the following parameter was recorded.

Firmness: Compactness of fruit was measured by a manual penetrometer (FP-503).

Percent weight loss: It was recorded by the formula:

$$\text{\% weight loss} = \frac{\text{Total weight loss}}{\text{Previous recorded weight}} \text{X100}$$

RESULTS AND DISCUSSION

Bio-chemical properties of fruits

The bio-chemical properties of velvet apple included TSS (%), pH, TA (%), vitamin-C (mg/100 g), reducing sugar (%), non-reducing sugar (%), total sugar, moisture content and dry matter (Table 1). Research results expressed that the highest TSS was (13.93%) in PSTU Bilati gab-2 and the lowest (9.78%) in local red variety. The pH varied from 6.23 to 7.50, where the highest pH is recorded from local yellow variety followed by local red variety (7.21) and the lowest (6.23) in PSTU Bilati gab-1, Haque *et al.* (2020) worked with eight velvet apple germplasm where they noted TSS with a ranges from 10.08 to 12.35% whereas Hossain *et al.* (2021) recorded TSS 11.13% and pH 5.02±0.45 those results closely supported the present findings. The titratable acidity varied from 0.83 – 1.30% among four germplasm. The highest vitamin-C (3.68 mg/100g) was found in both PSTU Bilati gab-1&2 followed by local red variety (2.31 mg/100g) and lowest (2.19 mg/100g) was recorded from local yellow variety. The reducing sugar content varied from 2.3 – 3.17% among the germplasm where PSTU Bilati gab-2 gave the highest non-reducing sugar (5.15%) followed by local red variety (2.14%), local yellow variety (2.03%) and lowest (1.25%) from PSTU Bilati gab-1. Similarly PSTU Bilati gab-2 gave the highest total sugar (7.95%) but the lowest (3.76%) was found from PSTU Bilati gab-1. Maximum moisture content of velvet apple pulp was measured in local red variety (83.95%) and minimum (81.48%) was in PSTU Bilati gab-2. On the contrary, the highest dry matter (18.53%) obtained from PSTU Bilati gab-2 and the lowest dry matter (16.05%) in local red variety (Figure 1). Similarities of those results were found in the findings of Haque *et al.* (2020) where they found Vitamin-C 4.36 – 8.75 mg/100g, ; Hossain *et al.* (2021) recorded TA 0.46±0.20%, total sugar 3.81±0.26 g/100g, reducing sugar 2.12±0.11 g/100g. Yadav *et al.* (2018) noted 2.2 mg/100g vitamin-C from the pulp of velvet apple that supported those findings.

Table 1. Boi-chemical properties of velvet apple.

Germplasm	TSS (%)	Pulp pH	TA (%)	Vitamin-C (mg/100g)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
G1	12.78^{ab}	7.21^{b}	0.86^{b}	2.31^{b}	3.17	2.14^{b}	5.30^{b}
G2	9.78^{c}	7.50^{a}	0.83^{b}	2.19^{b}	2.30	2.03^{b}	4.15^{bc}
G3	12.10^{b}	6.24^{c}	1.30^{a}	3.68^{a}	2.52	1.25^{b}	3.76^{c}
G4	13.93^{a}	6.23^{c}	1.25^{a}	3.68^{a}	2.80	5.15^{a}	7.95^{a}
Level of sign.	**	**	**	*	NS	**	**
CV (%)	13.72	1.78	9.03	8.12		16.14	12.91

Means in a column followed by the same letter (s) do not differ significantly analyzed by DMRT; NS= Non significant, **= Significant at 1% level of probability, *= Significant at 5% level of probability, CV = coefficient of variance, G1=local red variety, G2=local yellow variety, G3=PSTU Bilati gab-1 and G3= PSTU Bilati gab-2.

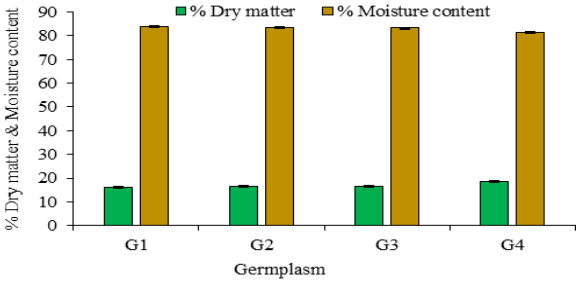

Figure 1. *Percent dry matter and moisture content of velvet apple germplasm. Vertical bars represent standard error.*

Table 2. Shelf life with different treatments.

Treatment	G1	G2	G3	G4
Open tray (control)	3.25^{e}	4.00^{e}	3.75^{e}	4.75^{e}
Paper bag	5.75^{d}	5.75^{d}	5.50^{d}	6.00^{c}
Perforated polybag	7.25^{c}	7.75^{c}	7.00^{c}	8.00^{b}
Non-perforated polybag	9.00^{b}	9.50^{b}	9.75^{b}	9.00^{b}
Refrigerator	26.25^{a}	27.25^{a}	26.00^{a}	27.00^{a}
Level of significance	**	**	**	**
CV (%)	4.69	4.37	5.34	4.57

Table 3. Firmness (N) of velvet apple at different days with different treatments.

Germplasm	Treatments	1st day	3rd day	5th day	7th day	9th day	11th day
G1	Open tray	1.21^{abc}	0.57^{e}	-	-	-	-
	Paper bag	1.20^{abc}	0.76^{abcde}	0.53^{ghij}	-	-	-
	PP	1.13^{abc}	0.93^{abc}	0.73^{cde}	0.40^{d}	-	-
	NPP	1.15^{abc}	0.75^{bcde}	0.84^{bcd}	0.67^{bc}	0.47^{c}	-
	Refrigerator	1.18^{abc}	1.03^{ab}	0.95^{ab}	0.93^{a}	0.85^{ab}	0.76^{a}
G2	Open tray	1.27^{a}	0.59^{de}	-	-	-	-
	Paper bag	1.24^{ab}	0.85^{abcde}	0.58^{fgh}	-	-	-
	PP	1.23^{ab}	0.80^{abcde}	0.57^{ghi}	0.38^{d}	-	-
	NPP	1.24^{ab}	1.08^{a}	087^{bc}	0.65^{bc}	0.40^{c}	-
	Refrigerator	1.18^{abc}	1.08^{a}	0.95^{ab}	0.92^{a}	0.87^{a}	0.70^{ab}
G3	Open tray	1.26^{a}	0.54^{e}	-	-	-	-
	Paper bag	1.22^{ab}	0.66^{cde}	0.44^{ij}	-	-	-
	PP	1.15^{abc}	0.77^{abcde}	0.56^{ghi}	0.39^{d}	-	-
	NPP	1.20^{abc}	0.96^{abc}	0.71^{def}	0.63^{c}	0.46^{c}	0.39^{b}
	Refrigerator	1.20^{abc}	1.05^{ab}	1.03^{a}	0.96^{a}	0.85^{ab}	0.73^{a}
G4	Open tray	1.09^{abc}	0.57^{e}	0.40^{j}	-	-	-
	Paper bag	1.03^{c}	0.75^{bcde}	0.57^{ghi}	0.40^{d}	-	-
	PP	1.06^{bc}	0.68^{cde}	0.53^{ghij}	0.40^{d}	-	-
	NPP	1.13^{abc}	0.84^{abcde}	0.66^{efg}	0.52^{cd}	0.40^{c}	-
	Refrigerator	1.09^{abc}	0.90^{abcd}	0.84^{bcd}	0.80^{ab}	0.74^{b}	0.65^{a}
Level of significance		**	*	**	**	**	**
CV (%)		6.10	14.99	7.93	12.62	13.50	26.25

Shelf life of velvet apple with different treatments

Shelf life of different velvet apple germplasm influenced by several treatments have been presented in Table 2. The longest shelf life (27 days) was recorded in refrigerator treatment of PSTU Bilati gab-2 followed by non-perforated polybag (9 days) that was statistically similar with perforated polybag treatment (8 days) but the least shelf life (4.75 days) was observed in open tray treatment. In local red variety the shelf life was highest (26.25 days) in refrigerator treatment followed by non-perforated polybag treatment (9 days) but the open tray treatment performed the shortest shelf life (3.25 days). In case of local yellow variety, 27.25 days shelf life was performed in refrigerator condition followed by non-perforated polybag (9.50 days) where it was only 4 days in open tray condition. Similarly, in PSTU Bilati gab-1, the highest shelf life (26 days) had been performed in refrigerator and second highest (9.75 days) in non-perforated polybag whereas the lowest shelf life (3.75 days) was in open tray. In all four germplasm refrigerator treatment provided the best result among the five storage treatment. It is due to minimum temperature prevail inside the refrigerator which inhibited respiration rate and restrict the activity of different microbial agents. Kumar and Thakur (2018) proved that persimmon (under the family ebenaceae) treated with 1-methylcyclopropene that extended the storage life of the fruit more than 30 days by suppressing the respiration along with retaining the firmness of the fruit that supported present research finding.

Firmness of velvet apple with different treatments

Firmness affected by different treatments have been presented in Table 3. It was found that the firmness reduced gradually with days. On harvest day, the highest firmness was recorded from both local yellow variety and PSTU Bilati gab-1 in open tray treatment were 1.27 N and 1.26 N, respectively. As successive result, on the 3rd day the highest hardness was observed in both NPP and refrigerator treatment (1.08 N) but in open tray all four germplasm showed the lowest firmness. Local red variety, local yellow variety and PSTU Bilati gab-1 got spoiled before the 5th day in open tray treatment. The highest firmness (1.03 N) was found in refrigerator treatment of PSTU Bilati gab-1 at 5th day. On the 7th day highest firmness (0.96 N) was recorded from PSTU Bilati gab-1 but the lowest firmness (0.38 N) was in local yellow variety. During the 9th day firmness was recorded from NPP and refrigerator treatment only where the highest value was 0.85 N in refrigerator condition in both local red variety and local yellow variety where the lowest was 0.4 N in NPP treatment in both Local yellow variety and PSTU Bilati gab-2. On the other hand, on 11th day, the hardness value was recorded in

Table 4. Percent weight loss of four velvet apple germplasm measured with five different treatments at time of its shelf life.

Germplasm	Treatment	3rd day	5th day	7th day	9th day	11th day
G1	Open tray	7.35^{a}	-	-	-	-
	Paper bag	4.51^{abcd}	4.75^{bc}	-	-	-
	PP	2.82^{bcde}	3.09^{cde}	2.89^{b}	-	-
	NPP	0.26^{e}	1.15^{ef}	0.68^{cd}	0.54^{abc}	-
	Refrigerator	2.22^{bcde}	1.81^{cdef}	0.68^{cd}	0.76^{ab}	0.98^{a}
G2	Open tray	5.20^{ab}	-	-	-	-
	Paper bag	3.35^{bcde}	2.98^{cdef}	-	-	-
	PP	1.20^{de}	1.18^{ef}	1.28^{bcd}	-	-
	NPP	1.96^{bcde}	1.49^{def}	1.90^{bc}	0.90^{a}	-
	Refrigerator	1.29^{cde}	1.44^{def}	1.30^{bcd}	0.63^{ab}	0.66^{a}
G3	Open tray	4.88^{abc}	6.93^{ab}	-	-	-
	Paper bag	4.49^{abcd}	4.36^{bcd}	-	-	-
	PP	0.77^{e}	0.78^{ef}	1.19^{bcd}	-	-
	NPP	1.12^{de}	1.05^{ef}	0.36^{cd}	0.26^{bc}	-
	Refrigerator	0.66^{e}	0.33^{ef}	0.33^{cd}	0.33^{bc}	0.66^{a}
G4	Open tray	4.93^{ab}	8.19^{a}	-	-	-
	Paper bag	5.54^{ab}	7.98^{a}	6.11^{a}	-	-
	PP	2.04^{bcde}	1.79^{cdef}	1.22^{bcd}	-	-
	NPP	1.17^{de}	1.05^{ef}	0.35^{cd}	0.47^{abc}	-
	Refrigerator	126de	1.52^{def}	0.32^{cd}	0.58^{ab}	0.15^{b}
Level of significance		**	**	**	**	**

Means in a column followed by the same letter (s) do not differ significantly analyzed by DMRT; NS= Non significant, **= Significant at 1% level of probability, *= Significant at 5% level of probability, - means whole sample spoiled before that day, CV = coefficient of variance, G1=local red variety, G2=local yellow variety, G3=PSTU Bilati gab-1 and G3= PSTU Bilati gab-2.

refrigerator treatment because samples of other treatments had been spoiled. In that case the highest firmness (0.76 N) was in local red variety and the lowest was 0.65 N in PSTU Bilati gab-2. At the onset of shelf life of velvet apple fruits the cell turgidity may higher which make them harder. With the extension of storage time the cell of fruits losses their turgidity that turned them softer.

Percent weight loss of velvet apple with different treatments

The responses of different treatments in relation to percent weight loss of fruits have been presented in Table 4. On the 3rd day, the highest weight loss (7.35%) was observed in local red variety at open tray condition and it was the lowest at NPP treatment of all germplasm. The highest weight loss was observed in both open tray (8.19%) and paper bag (7.98%) during 5th day where the lowest weight loss (0.33%) was occurred in refrigerator treatment in PSTU Bilati gab-1. On the 7th day, maximum weight loss (6.11%) recorded in PP treatment of PSTU Bilati gab-2 where it was minimum in refrigerator treatment (0.32 %) in the same germplasm. On the 9th day the fruits of NPP and refrigerator was edible and weight loss where maximum loss (0.90%) was in local yellow variety. On the other hand, only fruits of refrigerator treatment was in good condition on 11th day due to controlled weight loss where maximum was 0.98% in local red variety and minimum (0.15%) in PSTU Bilati gab-2. The rate of weight loss was highest in the earlier stage of storage which turned lower with days of storage. The reason might be due to the highest respiration rate in initial stage of storage life.

Conclusion

The findings of the research explicitly expressed that PSTU Bilati gab-2 was the best in most of the bio-chemical traits except pH and reducing sugar content and it also provided highest dry matter. The longest shelf life was confirmed from PSTU Bilati gab-2 at control treatment. When the fruit sample were kept with different storage condition, refrigerator provided the longest shelf life but among other treatments non-perforated polybag performed satisfactory result. Both the firmness and weight loss was minimized in refrigerator followed by non-perforated polybag treatment. So, overall assessment revealed that PSTU Bilati gab-2 was the best over germplasm and refrigerator was the best treatment but other than refrigerator non-perforated polybag can be recommended for storage of velvet apple.

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Conflict of interest

The authors declare there are no conflicts of interest.

REFERENCES

Ahmed, M., Mozumder, S. N., Firoz, Z. A., & Faisal, S. M. (2011). Variability and performance of superior velvet apple (*Diospyros discolor*) germplasm in the hilly region. *Bangladesh Journal of Agricultural Research*, *36*(2), 223-230.

Das, S. C., Hamid, K., Bulbul, I. J., Sultana, S., & Islam, S. (2010). In vitro antioxidant activity of different parts of the plant *Diospyros discolor*. *Research Journal of Agriculture and Biological Sciences*, *6*, 472-475.

Greuter, W. (2000). International code of botanical nomenclature (Saint Louis Code). *Regnum vegetabile*, *138*, 1-474.

Haque, M. N., Saha, B. K., Karim, M. R., & Bhuiyan, M. N. H. (2009). Evaluation of nutritional and physico-chemical properties of several selected fruits in Bangladesh. *Bangladesh Journal of Scientific and Industrial Research*, *44*(3), 353 -358.

Haque, M. R., Hossain, M. M., & Rahim, M. A. (2020). Morpho-biochemical evaluation of eight Velvet apple (*Diospyros discolor* Willd.) germplasms. *International Journal of Minor Fruits, Medicinal and Aromatic Plants*, *6*(2), 45 – 55.

Hossain, M. M., Rahim, M. A., & Haque, M. R. (2021). Biochemical properties of some important underutilized minor fruits. *Journal of Agriculture and Food Research*, *5*, 100148.

Kumar, N., & Thakur, K. S. (2018). Extending postharvest storage life of non-astringent persimmon cv. Fuyu by 1-MCP treatments. *International Journal of Bio-resource and Stress Management*, *9*(1), 114-117.

Lane, M. & Etymon, F. (1923). Physical and chemical characteristics of off ripened mango (*Mangifera indica* L.) fruit (Dodo). *African Journal of Biotechnology*, *6* (21), 2477 -2483.

Lee, S. E., Hwang, H. J., Ha, J. S., Jeong, H. S., & Kim, J. H. (2003). Screening of medicinal plant extracts for antioxidant activity. *Life sciences*, *73*(2), 167 -179.

Lim, T. K., & Lim, T. K. (2012). *Diospyros blancoi*. *Edible Medicinal And Non-Medicinal Plants: Volume 2, Fruits*, 421-424.

Ranganna, S. (1979). Manual of Analysis of Fruits and Vegetables Products, TataMcGrew Hill Publ. *Co. New Delhi*, 102-140.

Recuenco, M. C., Lacsamana, M. S., Hurtada, W. A., & Sabularse, V. C. (2016). Total phenolic and total flavonoid contents of selected fruits in the Philippines. *Philippine Journal of Science*, *145*(3), 275-281.

Singh, R. (1998). Fruits National Book Trust, A-5, *Green Park*, *New Delhi*, *India*. pp. 200.

Somat, N. A., Yusoff, Z., & Osman, C. P. (2020). Chemical constituents from Diospyros discolor Willd. and their acetylcholinesterase inhibitory activity. *Pharmacognosy Journal*, *12*(6s), http://10.5530/pj.2020.12.212

Yadav, M., Srilekha, K., & Maheswari, K. U. (2018). Potential health benefit of underutilized fruits: A review. *Journal of Pharmacognosy and Phytochemistry*, *7* (5), 1417-1420.