Original Research Article

Physico-chemical Properties Comparison Between Released Varieties and Local Germplasm of Sapota (*Manilkara Zapota*)

ABSTRACT

A study on physico-chemical properties comparison between realesed varieties and local germplasm of sapota was conducted with a view to selecting the superior germplasm in respect of nutritional quality. Samples were collected from selected ten (10) sapota plants at different homestead of Dumki Upazila, Germplasm Center, PSTU and Bangladesh Agricultural Research Institute, Gazipur and chemical analysis was done at Plant Biotechnology Lab and Postharvest Lab, Patuakhali Science and Technology University. The highest fruit length (4.85cm), width (4.93 cm), weight (115.33 g), edible portion (92.33%), phenolic content (2.537 mg/100gm), anthocyanin content (1.807µg/100gm) were exhibited in G3 and carotenoid content (5.320µg/100gm) and (5.173µg/100gm) were found in G3 and G1. The lowest fruit length (3.13cm) in G4, width (3.60 cm) inV10, weight (61.33 g) in G4, edible portion (56%) in V6, phenolic content (1.033mg/100g) in G4, anthocyanin content (.586µg/100gm) in V7, carotenoid content (1.277µg/100gm) in V5 were found. The highest peel weight (6.80 g) in G1 and the lowest peel weight (5.10g) in V7 were exhibited. The highest percentage of TSS (21.28%) was found in V10 and lowest (7.53%) was found in G1. The maximum vitamin-C (11.42 mg/100g) content was found in G1 and minimum (3.38mg/100g) was found in V7. The highest carbohydrate (22.99%) content was exhibited in G2 and lowest (11.68%) in V5. The antioxidant (95.80mg/100gm) content was highest in V9 and lowest (80.64 mg/100gm) in G4. So, overall findings of this study were - G3 was superior in respect of physic-chemical characteristics. G1 exhibited the highest Vitamin-C content and G2 exhibited the highest percentage of carbohydrate. V10 exhibited the highest percentage of TSS and the highest percentage of antioxidant was exhibited in V9. Based on physicochemical properties an overall performance grading of the germplasm/varieties were done as follows- G3 > G1, G2, V9, V10 > G4, V5, V6, V7, V8

Keywords: Physico-chemical properties; Released Varieties; Local Germplasm; Sapota

1. INTRODUCTION

Sapodilla (*Manilkara Zapota* L.) which belongs to the family sapotaceae, is underutilized tropical fruits commonly known as “sapota”. Generally in Bengali it is known by the people as sofeda. Immature fruits are hard, gummy and rich in tannin, while the ripe fruits are soft and juicy, with a sweet taste an attractive range colour, which makes them wonderful dessert fruit [9]. From late October to late November it is usually available in our country. It grows well throughout the country, as we are in the tropical environment. Sofeda tree yields fruits two times a year. Sapota is an important minor fruit crop and can be considered as one of the healthy fruits because of the presence of various nutritious components in it. Sapota fruits is reported to contain sugar, acids, protein, amino acid, phenolics, gallic acid, catechin, chlorogenic acid, leucodelphinidin, and leucodelargonidin and Leucopelargonidin, carotenoids, ascorbic acids, and minerals like potassium, calcium and iron [6]. Fruits contains carbohydrate (50.49 g/100 g), protein (0.7 g /100g), fat (1.1 g /100g), fiber (2.6g /100g), and minerals nutrient such as calcium (28mg /100g), iron (2.0mg /100g), phosphorus (27mg /100g), ascorbic acid (6.0mg /100g) [4]. People of Bangladesh are generally poorly nourished. Most of the people suffer from mal-nutrition and resultant diseases. It is needed to improve the nutritional status and to increase the food security, particularly for the rural poor. If we can utilize the minor, they may help to contribute in food security, nutrition, health, income generation [5]. In this study an attempt has been made to assess the physico-chemical properties of local germplasm and released varieties and proper categorization of the released varieties and local germplasm of sapota according to their nutritional quality which help in selection of superior germplasm with higher nutritional qualities from among the existing local germplasm. This study will be conducted with the hope that this work may encourage further production, processing and marketing of sapota.

2. MATERIALS AND METHODS

The present experiment was undertaken to study the physical and chemical characteristics of local germplasm and released varieties of sapota. For the convenience of presentation, this section has been divided into various sub sections. The details of the experiment and methods are described below.

2.1 Duration and location

The study was conducted during March, 2018 to February, 2019 at the Plant Biotechnology Lab and Postharvest Lab, Department of Horticulture, Patuakhali Science and Technology University, Bangladesh.

2.2 Sample collection

With a view to selecting the local germplasm and released varieties of sapota, four local germplasm were collected from different homestead of Dumki upazila and six released varieties were collected from Germplasm Center, Department of Horticulture, PSTU and Bangladesh Agricultural Research Institute, Gazipur (BARI). Samples were named as G_1, G_2, G_3, G_4= Germplasm, V_5= BAU-1, V_6= BAU-2, V_7= BAU-3, V_8= BARI-1, V_9=BARI-2 and V_{10}= BARI-3 were used for Study.

2.3 Treatments and their combinations

Each selected plant was considered as a treatment. Each treatment was replicated for 4 times by selecting 4 branches randomly. So, the experiment was comprised of 10 treatments with 4 replications. Therefore, treatment combination was 40.

2.4 Design and layout of the experiment

The laboratory experiment was done in Completely Randomized Design (CRD) with 4 replications.

2.5 Experimental observations

2.5.1 Physical Characteristics

*2.5.1.1 Fruit shape:*The fruit shape was observed through eye estimation.

2.5.1.2 Fruit weight measurement: Fully matured 40 (1 fruits × 4 branches × 10 plants) fruits were gradually collected to find out the mean weight and other measurement of fruits. The weight was taken in gram with the help of an electrical balance.

2.5.1.3 No. of seeds per fruit: Number of seeds per fruit was manually counted after the fruit ripe. Soft fruits were used to calculate the number of seeds per fruit.

2.5.1.4 Seed weight measurement: Fully ripe and soft fruit was used to collect the seeds. Seeds were separated from pulp and washed thoroughly with distilled water. Then the adjacent water was removed with the help of paper. After that the weight of seeds was taken in gram with the help of a balance sensitive to ten (10) g.

2.5.1.5 Peel weight measurement: Peel weight data was measured from (fruit weight - seed weight+ pulp weight).

2.5.1.6 Colour of pulp: Colour of pulp observed through eye estimation.

2.5.1.7 Fruit length measurement: Length of the fruits was measured from basal to polar by using slide calipers and a total of 40 (1 fruits × 4 branches × 10 plants) fully matured fruits were used to determine the length of fruits in centimeter.

2.5.1.8 Fruit width measurement: Diameter of the fruits was measured by using slide calipers and a total of 40 (1 fruits × 4 branches × 10 plants) fully matured fruits were used to determine the width of fruits in centimeters.

2.5.1.9 Percentage of edible portion: The percentage of edible (pulp) portion was measured by using the following formula [11],

$$\text{Percent of edible portion} = \frac{\text{Weight of edible parts}}{\text{Weight of whole fruit}} \times 100$$

2.5.1.10 Weight loss after 7 days: The percentage of weight loss after 7 days was measured by using the following formula:

$$\text{Weight loss (\%)} = \frac{W_1 - W_n}{W_1} \times 100$$

Where, W_1 = Initial weight of sapota fruit

W_n = Weight of sapota fruit after 7 days

2.5.2 Chemical Characteristics

For chemical evaluation, 9 different chemical characteristics (TSS, TA, Vitamin C, p^H, Carbohydrate, antioxidant, phenol, Anthocyanin, Carotenoid) were observed.

2.5.2.1 Determination of Total Soluble Solids (TSS): The TSS of sapota pulp was determined by using a digital refractometer (BOECO, Germany). The remaining of the filtrated juice from TA determination was used to measure the TSS of the fruit pulp. Before measurement, the refractometer was calibrated with distilled water to give a 0% reading. About 1-2 drops of the filtrate was placed on the prism glass of the refractometer to obtain the % TSS reading. The readings were multiplied by dilution factor to obtain an original % TSS of the pulp tissues. Since difference in sample temperature could affect the measurement of TSS, each of the reading was standardized to a temperature of 20°C by adding 0.28% to obtain % TSS at 26 ± 1°C.

2.5.2.2 Determination of Titratable Acidity (TA): Titratable acidity (TA) was determined according to the following method [8]. Ten grams of pulp tissues were homogenized with 40 ml of distilled water using a kitchen blender for two minutes and filtered through a Whatman filter paper No.2. Five milliliters of the filtrate was transferred into a 100 ml conical flask and two drops of 1% phenolphthalein solution as an indicator were added. The sample was titrated with 0.1 M sodium hydroxide (NaOH) solution until the color changed to pink and persistent for at least 15 seconds. The titrate volume was recorded and the result was expressed as percentage citric acid, which was calculated using the following formula:

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

2.5.2.3 Determination of ascorbic acid (Vitamin C): Ascorbic acid content was determined according to the following method [8]. The following reagents were used for the estimation of ascorbic acid content.

Three percent (3%) meta phosphoric acid (HPO_3): It was prepared by dissolving the sticks of HPO_3 in distilled water.

Standard ascorbic solution: Ten milligram percent (10 mg%) of L-ascorbic acid solution was prepared by dissolving ascorbic acid in 3% meta phosphoric acid solution.

Dye solution: It was prepared by dissolving 50 mg of the sodium salt of 2, 6-dichlorophenol indophenol in approximately 50 ml of hot distilled water containing 42 mg of sodium bicarbonate. It was then cooled and diluted to 100 ml with distilled water. The following steps were followed for the estimation of ascorbic acid.

Standardization of dye solution: Ten milliliters (10 ml) of standard ascorbic acid solution was taken in a conical flask and 5 ml of metaphosphoric acid HPO_3 was added to it. A micro burette was filed with the dye solution. The content of the conical flask was titrated with dye solution. The content of conical flask was titrated with dye till the pink-colored end point appeared. The milliliters of dye solution required to complete the titration was recorded. Dye factor was calculated using the following formula:

$$\text{Dye factor} = \frac{0.5}{\text{Titre (ml)}}$$

Preparation of sample: About five grams (5g) of fresh fruit and 35 ml of 3% meta-phosphoric acid solution was taken in a blender and homogenized for 2 minutes. After blending it was filtered and centrifuged at about 2000 ppm for 5 minutes. The supernatant homogenized liquid was transferred to a 50 ml volumetric flask and the volume was made up with 3% metaphosphoric acid.

Procedure: Ten milliliters (10 ml) of the aliquot was taken in a conical flask and titrated with dye solution. The ascorbic acid content of the samples was calculated by using the following formula:

Ascorbic acid (mg 100 g^{-1}) =

$$\frac{\text{Titre (ml)} \times \text{dye factor (0.125)} \times \text{vol. made up (50 mL)} \times 100}{\text{Aliquot used for estimation (5 mL)} \times \text{sample weight (10g)}}$$

2.5.2.4 Determination of pH: The remainder of the filtrated juice from TA determination was used to measure the pH of the fruit pulp. The pH was determined by using a glass electrode pH meter (GLP 21, Crison, Barcelona, EEC). The pH meter was calibrated with 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. For accuracy of the reading, the glass electrode was washed after each reading with distilled water and wiped to dry with soft tissue paper.

2.5.2.5 Determination of total soluble carbohydrates: Total soluble carbohydrates were estimated by phenol sulphuric acid method [2].

Reagent: 80% Ethanol**,** 80% Phenol**,** Sulphuric acid

Procedure: Extraction of total soluble carbohydrates from one gram of pulp was weighted and digested by hot ethanol 80% two times, each time by 5ml ethanol and then filtered by whatman No.2 filter paper and the extracts diluted by distilled water to the volume of 50ml.

1ml sample placed in a test tube and then 1ml p- phenol solution added. The procedure was followed by adding 5ml of sulfuric acid and well shaking. A reagent blank was prepared by taking 1ml of water, 1ml p-phenol and 5ml of sulfuric acid in a test tube and treated similarly. The yellow- orange color was pipetted off and wave length was read in 490 nm by spectrophotometer machine.

The standard curve was prepared by taking 0.0, 0.1, 0.2, 0.4, 0.6, 0.8, 1.0ml of standard glucose solution in different test tube containing 0.0 µg, 10µg, 20 µg, 40 µg, 60 µg, 80 µg and 100 µg of glucose respectively and made the volume up to 1.0 ml with distilled water. 1ml phenol and 5ml sulfuric acid was added to each test tube and mixed well. All the solution treated similarly as

described above. The absorbance was measured at 490 nm. The total carbohydrate content was calculated from a calibration curve, y = 0.0038x + 0.0088 R^2 = 0.9996, (curve 3.3) where y is absorbance and x is concentration of glucose.

Finally the percentage of total soluble carbohydrate present in sample was determined using the formula given below-

Calculation: Percentage of total soluble carbohydrate (gm per 100 gm of sample)

$$\frac{\text{Weight of total soluble carbohydret obtained}}{\text{Weightof sample}} \times 100$$

2.5.2.6 Determination of phenolic content and Antioxidant

Sample preparation: At first 6gm sample was taken in petridish and kept in oven at 3 hours in 60^0C temperature. Then 2 gm sample were dissolved in 50 ml methanol in a falcon tube to prepare a stock solution. The solutions were vortexes and solicited for several minutes (20-30 minute). The stock solution were preserved in room temperature and diluted to necessary concentration when needed.

Chemical and reagents: Folin-Ciocalteau reagent, Gallic cacid, Rutin Hydrate, TPTZ, ferric chloride, sodium hydroxide and methanol were purchased from Merck, Germany. 2, 2-diphenyl-l-picrylhydrazyl (DPPH) was purchased from Sigma Aldrich Co. Ascorbic acid and NBT were purchased from BDH Co. and ferrozine from Loba India. All the chemicals and reagents were of analytical grade.

2.5.2.7 Determination of total phenolic content: Phenols, sometimes called phenolic are one of the main secondary metabolites present in the plant kingdom

Reagents: Folin-Ciocalteu reagent (0.5 N), Saturated sodium carbonate (20%), Gallic acid (10 µg/ml)

Procedure: The amount of total phenolic content was determined following the established method [1] with some modifications. A 0.5ml of extract (concentration of extract is 1.0 mg/ ml) and 0.5 ml of Folin-Ciocalteu reagent (0.5 N) were mixed and incubated at room temperature for 5 minutes. Then 2.0 ml saturated sodium carbonate was added and further incubated for 30 minutes at room temperature.

2.5.2.8 Determination of total antioxidant capacity: Determination of total antioxidant activity was done as per as the phosphor molybdenum method with some modification [7]. The basic principle of the assay is based on the reduction of Mo (VI) to Mo (V) by the extract and subsequent formation of a green phosphate Mo (V) complex at acidic pH.

Reagent: 6M sulfuric acid, 28mM sodium phosphate, 4mM ammonium molybdate

Procedure: 1 ml extract was combined with a mixture of 3ml of reagent solution (0.6M sulfuric acid, 28mM sodium phosphate and 4mM ammonium molybdate). The tubes containing the reaction solution were then capped and incubated at 95°C for 90 minutes. After the samples had cooled to room temperature, the absorbance of the solution was then measured at 695 run against blank. Methanol (1 ml) in the place of extract is used as the blank. The total antioxidant content was calculated from a calibration curve y = 256.11x -12.645, R2 = 0.9974, where x is absorbance and y is concentration of Gallic acid. The antioxidant activity is expressed as the mg of equivalents of Gallic acid.

2.5.2.9 Determination of total anthocyanin: Total anthocyanin content of leather was determined by the following method [10]. For the chlorophyll measurement, 5g tissue samples were properly homogenized with 10ml (1:2) 80% cold acetone (80:20 vol: vol, pH = 7.8) and centrifuged for 4 min at 800 rpm at 4^0c. The clear supernatant diluted to a final volume of 5 ml with additional acetone and was used for the estimation of the total anthocyanin content and evaluated for antioxidant activity. The absorbance of the extract solutions at 665, 649, 646, 663, 470, 52 and 650nm wave lengths was measured with a double beam spectrophotometer (Dynamica HALO-DB-20S UV-VIS Double Beam Spectrophotometer). The contents of chlorophyll-a and chlorophyll-b as well as anthocyanin was calculated by using the following formula:

Chlorophylla-a (µg/ml) = 12.21 A_{665} – 6.88 A_{649}

Chlorophylla-b (µg/ml) = 20.13 A_{646} – 5.03 A_{66}

Anthocyanin(µmol/ml) = A_{529} – 0.288 A_{650}

Anthocyanin (µmol/g × 207.247 = µg/g) = A_{529} – 0.288 A_{650}

Where, Ax is the absorbance of the extract solution in a 1-cm path length cuvette at wavelength x.

2.5.2.10 Determination of total carotenoids: The total carotenoids of the leather pulp were determined by the following method [10]. The sample preparation for the absorbance reading was done as described in 3.7.1. The absorbance of the extract solutions at 665, 649, 646, 663, 470, 529 and 650nm wave lengths were measured with a double beam spectrophotometer.

Then the contents of chlorophyll-a and chlorophyll-b as well as total carotenoids were calculated using the following formula:

Chlorophylla-a (µg/ml) = 12.21 A_{665} – 6.88 A_{649}

Chlorophylla-b (µg/ml) = 20.13 A_{646} – 5.03 A_{663}

Carotenoids (µg/ml - µg/g) = $\frac{1000\ A\ 470 - 3.27\ Ca - 104\ Cb}{229}$

Where, Ax is the absorbance of the extract solution in a 1-cm path length cuvette at wavelength x.

2.6 Statistical analysis

The collected data on various parameters under this study were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done with the help of MSTAT-C computer package program. The mean differences among the treatments were calculated with the help of Duncan's Multiple Range Test (DMRT) at 1% and 5% levels of probability [3].

3 RESULTS AND DISCUSSION:

3.1 Physical Characteristics

Significant variation was observed among the selected local germplasm and released varieties in respect of fruit length. The longest fruit length was obtained from local germplasm G3 and varieties V9 and V7 (4.87, 4.85 and 4.60 cm) whereas the shortest fruit was found in G4 (3.13 cm) (Table 1).

Statistically significant variation was observed among the selected local germplasm and released varieties in respect of fruit width. The highest fruit width was obtained from local germplasm G¬3 (4.93 cm) whereas the lowest fruit width was recorded from variety V10 (3.60 cm) (Table 1).

Significant difference was observed in respect of fruits weight among the selected varieties and local germplasm of sapota. The highest fruit weight was recorded in local germplasm G3 (115.33 g) whereas the lowest fruit weight was recorded from the local germplasm G4 (61.33 g) which was statistically identical with V7 (63.17 g) (Table 1).

Significant difference was observed in respect of peel weight among the selected local germplasm and released varieties. The highest peel weight was recorded in germplasm G1 and variety V9 (6.80 and 6.76 g) whereas the lowest peel weight was recorded from the variety V7 (5.10 g) which was statistically identical with G2 (5.20 g) (Table 1).

Significant variation was observed among the selected released varieties and local germplasm of sapota in respect of edible portion. The highest pulp edible portion was exhibited in G3 and V10 (92.33 and 92.00 g) whereas the lowest edible portion was recorded in varietyV6 (56.00 g) (Table 1).

Table 1: Length of fruit, width of fruit, weight of fruit, weight of peel and edible portion of selected local germplasm and released varieties of sapota

Sl. No.	Length of fruit (cm)	Width of fruit (cm)	Weight of fruit (g)	Weight of peel (g)	Edible portion (%)
G_1	4.10 b	4.60 d	87.33 d	6.80 a	88.67 b
G_2	3.97 b	4.40 e	96.00 c	5.20ef	91.00 ab
G_3	4.87 a	4.93 a	115.33 a	6.47 b	92.33 a
G_4	3.13 d	3.88 f	61.33i	5.77 c	62.00 f

V_5	4.13 b	4.85 b	72.00 f	5.60 d	65.33 e
V_6	3.55 c	4.40 e	67.83 g	5.30 e	56.00 g
V_7	4.60 a	4.75 c	63.17 hi	5.10 f	64.33ef
V_8	3.50 c	4.85 b	77.50 e	6.46 b	84.67 c
V_9	4.85 a	4.77bc	65. 00 h	6.76 a	81.00 d
V_{10}	4.17 b	3.60 g	112.67 b	6.50 b	92.00 a
Level of Sig.	**	**	**	**	**
CV (%)	4.10	1.07	1.69	1.48	2.04

Means in a column followed by the same letter (s) do not differ significantly by DMRT.

** Significant at 1% level of probability

Here, G1, G2, G3, G4= Local germplasm, V5= BAU-1, V6= BAU-2, V7= BAU-3, V8= BARI-1, V9=BARI-2 and V10= BARI-3

There was no significant difference found in case of number of seed, weight of seed, weight loss after 7 days and fruit shape of selected sapota germplasm and varieties.

Table 2: Number of seed, weight of seed, weight loss after 7 days and fruit shape of selected germplasm and released varieties of sapota

Sl. No.	Number of seed	Weight of seed (g)	Weight loss after 7 days (%)	Fruit shape
G_1	3.00	1.26	25.44	Round
G_2	2.67	1.60	29.86	Round
G_3	2.67	1.63	25.33	Round
G_4	3.33	1.67	21.67	Round
V_5	2.67	1.56	24.33	Round
V_6	3.00	1.66	25.07	Round
V_7	3.33	1.96	26.00	Round
V_8	2.67	1.40	25.00	Round
V_9	2.67	1.53	21.67	Round
V_{10}	3.33	1.77	27.33	Round
Level of Sig.	NS	NS	NS	
CV (%)	14.96	14.95	13.07	

Means in a column followed by the same letter (s) do not differ significantly

By DMRT,

NS= Non significant

Here, G1, G2, G3, G4= Local germplasm, V5= BAU-1, V6= BAU-2, V7= BAU3, V8= BARI-1, V9=BARI-2 and V10= BARI-3

3.2 Chemical Characteristics

3.2.1 pH: No significant variation was observed in case of pH content among the local germplasm and released varieties of sapota.

3.2.2 Titratable acidity (%): No significant variation was observed in case of TA content among the local germplasm and released varieties of sapota.

3.2.3 Total soluble solids (%): The percentage of total soluble solids (TSS) showed significant variation among different released varieties and local germplasm of sapota. The highest percentage of TSS was found in V10 variety (21.28%) while the lowest percentage was found in local germplasm G1 (7.53%) (Figure 1).

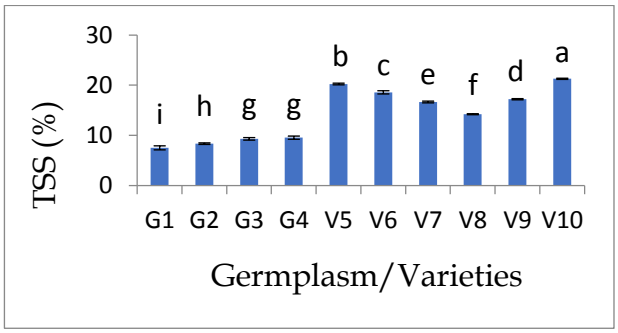

Figure 1: TSS content of selected sapota fruits

Vertical bar represent error bar with standard deviation

Here, V1= Local verity, V2= Local verity, V3= Local verity, V4= Local verity, V5= BAU-1, V6= BAU-2, V7= BAU-3, V8= BAR-1, V9=BARI-2 and V10= BARI-3

3.2.4 Vitamin-C (mg/100g): The ascorbic acid content of fruits varied significantly among the released varieties and local germplasm of sapota. It was found that, the vitamin-C content was higher in local germplasm G1 and G2 (11.42 and 11.33 mg/100g) whereas the lower vitamin-C content was found in V7 variety (3.38 mg/100g) (Figure 2).

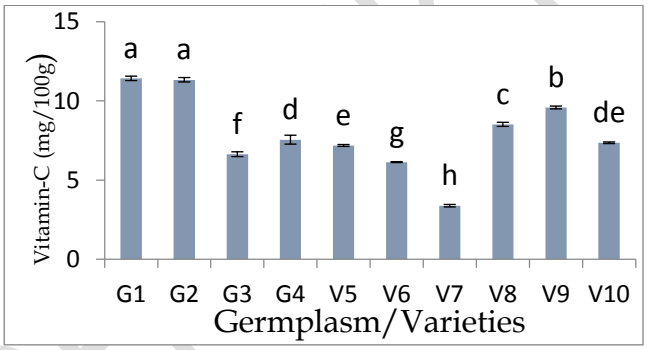

Figure 2: Vitamin-C content of selected sapota fruits

Vertical bar represent error bar with standard deviation

Here, V1= Local verity, V2= Local verity, V3= Local verity, V4= Local verity, V5= BAU-1, V6= BAU-2, V7= BAU-3, V8= BARI-1, V9=BARI-2 and V10= BARI-3

3.2.5 Carbohydrate content (%): Significant variation was observed in case of carbohydrate content among the selected local germplasm and released varieties. It was found that, the carbohydrate content was higher in local germplasm G2 (22.99%) whereas the lower carbohydrate content was counted in V5 variety (11.68%) (Figure 3).

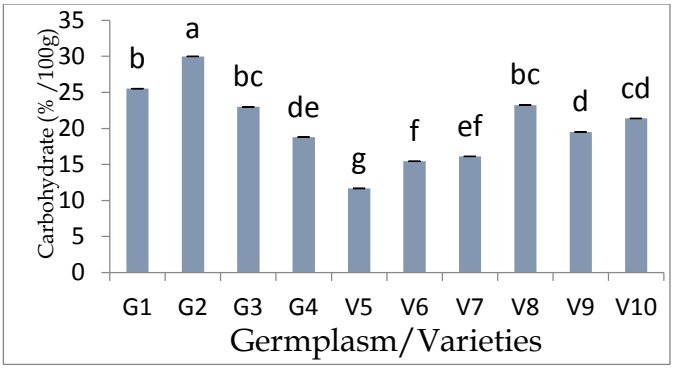

Figure 3: Carbohydrate content of selected sapota fruits

Vertical bar represent error bar with standard deviation

Here, V1= Local verity, V2= Local verity, V3= Local verity, V4= Local verity, V5= BAU-1, V6= BAU-2, V7= BAU-3, V8= BARI-1, V9=BARI-2 and V10= BARI-3

3.2.6 Phenolic content: Significant variation was observed in case of total phenolic content among the selected sapota germplasm and released varieties. It was found that, the phenolic content was higher in local germplasm G3 (2.537 mg\100gm). whereas the lower phenolic content was found in local germplasm G4 (1.033mg\100gm) (Figure 4).

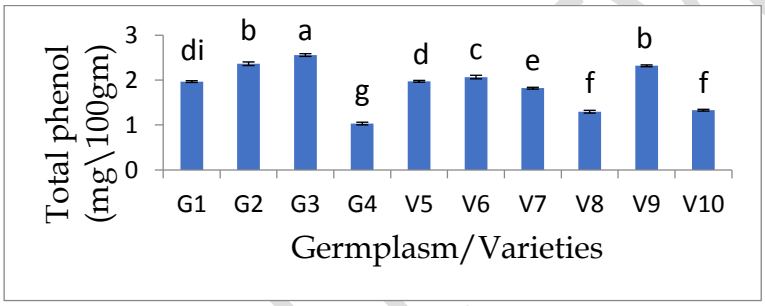

Figure 4: Total Phenolic content of selected sapota fruits

Vertical bar represent error bar with standard deviation

Here, V1= Local verity, V2= Local verity, V3= Local verity, V4= Local verity, V5= BAU-1, V6= BAU-2, V7= BAU-3, V8= BARI-1, V9=BARI-2 and V10= BARI-3

3.2.7 Antioxidants content: Significant variation was observed in case of total antioxidants content among the selected germplasm and released varieties. It was found that, the antioxidant was higher in V9 variety (95.80 mg\100gm). whereas the lower antioxidant content was found in local germplasm G4 (80.64mg\100gm) (Figure 5).

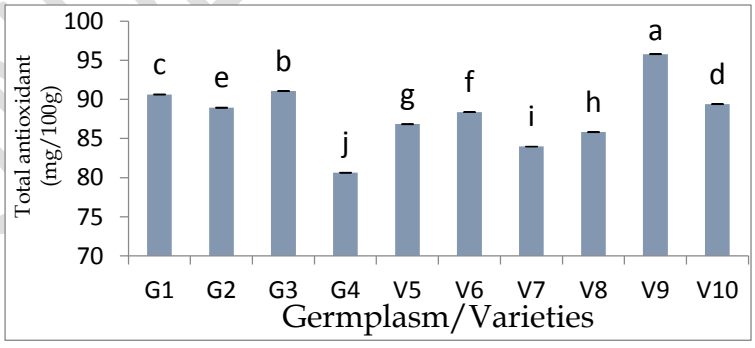

Figure 5: Total antioxidant content of selected sapota fruits

Vertical bar represent error bar with standard deviation

Here, V1= Local verity, V2= Local verity, V3= Local verity, V4= Local verity, V5= BAU-1, V6= BAU-2, V7= BAU-3, V8= BARI-1, V9=BARI-2 and V10= BARI-3

3.2.8 Anthocyanin content: Significant variation was observed in case of anthocyanin content among the selected sapota germplasm and released varieties. It was found that, the anthocyanin content

was higher in germplasm G3 (1.807µg\100gm). whereas the lower anthocyanin content was found in V6 (.6667µg\100gm), G4 (.6100µg\100gm), and V7 (.5867µg\100gm) (Figure 6).

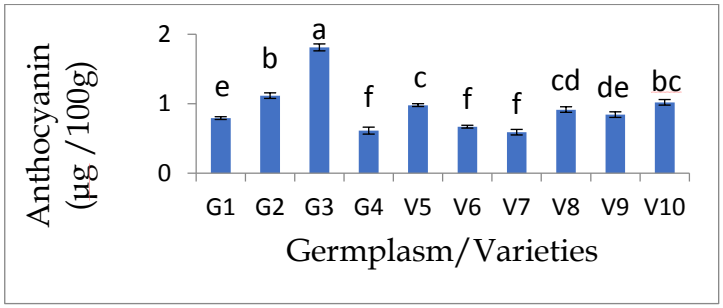

Figure 6: Anthocyanin content of selected sapota fruits

Vertical bar represent error bar with standard deviation

Here, V1= Local verity, V2= Local verity, V3= Local verity, V4= Local verity, V5= BAU-1, V6= BAU-2, V7= BAU-3, V8= BARI-1, V9=BARI-2 and V10= BARI-3

3.2.9 Carotenoid content: Significant variation was observed in case of carotenoids content among the selected sapota germplasm and released varieties (Figure 13). It was found that, the carotenoids content was higher in germplasm G1 (5.173µg\100gm) and G3 (5.320µg\100gm). whereas the lower carotenoids content was found in V5 variety(1.277µg\100gm) (Figure 7).

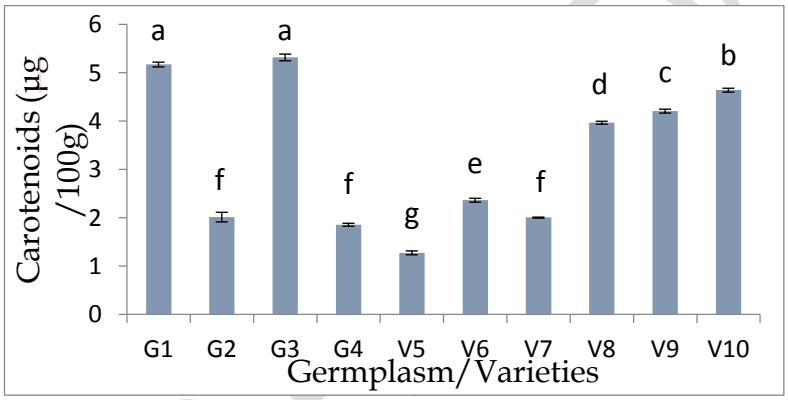

Figure 7: carotenoids content of selected sapota fruits

Vertical bar represent error bar with standard deviation

Here, V1= Local verity, V2= Local verity, V3= Local verity, V4= Local verity, V5= BAU-1, V6= BAU-2, V7= BAU-3, V8= BARI-1, V9=BARI-2 and V10= BARI-3

4. SUMMARY AND CONCLUSION:

From the above study nutritional contents varied among the studied germplasm. The highest fruit length (4.85cm), width (4.93 cm), weight (115.33 g) and edible portion (92.33%) were exhibited in G_3. The lowest fruit length (3.13cm) in G_4 and width (3.60 cm) in V_{10}, weight (61.33 g) in G_4 and edible portion (56%) were found in V_6. The highest peel weight (6.80 g) in G_1 and the lowest peel weight (5.10g) in V_7 were exhibited. The highest percentage of TSS (21.28%) was found in V_{10} and lowest (7.53%) was found in G_1. The maximum vitamin-C (11.42 mg/100g) content was found in G_1 and minimum (3.38mg/100g) was found in V_7. The highest carbohydrate (22.99%) content was exhibited in G_2 and lowest (11.68%) in V_5. The phenolic content (2.537 mg/100gm) was highest in G_3 and lowest (1.033mg/100g) in G_4. The antioxidant (95.80mg/100gm) content was highest in V_9 and lowest (80.64 mg/100gm) in G_4. The highest (1.807µg/100gm) anthocyanin content was exhibited in G_3 and lowest (.586µg/100gm) in V_7. The carotenoid content were highest (5.320µg/100gm), (5.173µg/100gm) in G_3 and G_1 and lowest (1.277µg/100gm) in V_5. So, overall findings of this study were - G_3 was superior in respect of fruit length, width, weight, edible portion, phenol, anthocyanin and carotenoid content. G_1 exhibited the highest Vitamin-C content and G_2 exhibited the highest percentage of carbohydrate. V_{10} exhibited the highest percentage of TSS and the highest percentage of antioxidant was exhibited in V_9. Based on

physicochemical properties the germplasm/varieties were graded as follows- $G_3 > G_1, G_2, V_9, V_{10} > G_4, V_5, V_6, V_7, V_8$

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Appendix 1: Analysis of variance (ANOVA) of physical characteristics of sapota

Sl .No.	Length of fruit(cm)	Width of fruit(cm)	Weight of fruit(g)	Weight of peel (g)	Edible portion (%)	Number of seed	Weight of seed (g)	Weight loss after 7 days (%)
Replication	0.061	0.016	1.633	0.012	4.933	0.933	0.137	1017.023
Factor A	1.006**	2.382**	1222.471**	1.356**	608.059**	0.281^{NS}	0.109^{NS}	17.607^{NS}
Error	0.028	0.009	1.902	0.008	2.526	0.0193	0.058	10.819

Appendix 2:Analysis of variance (ANOVA) of chemical characteristics of sapota

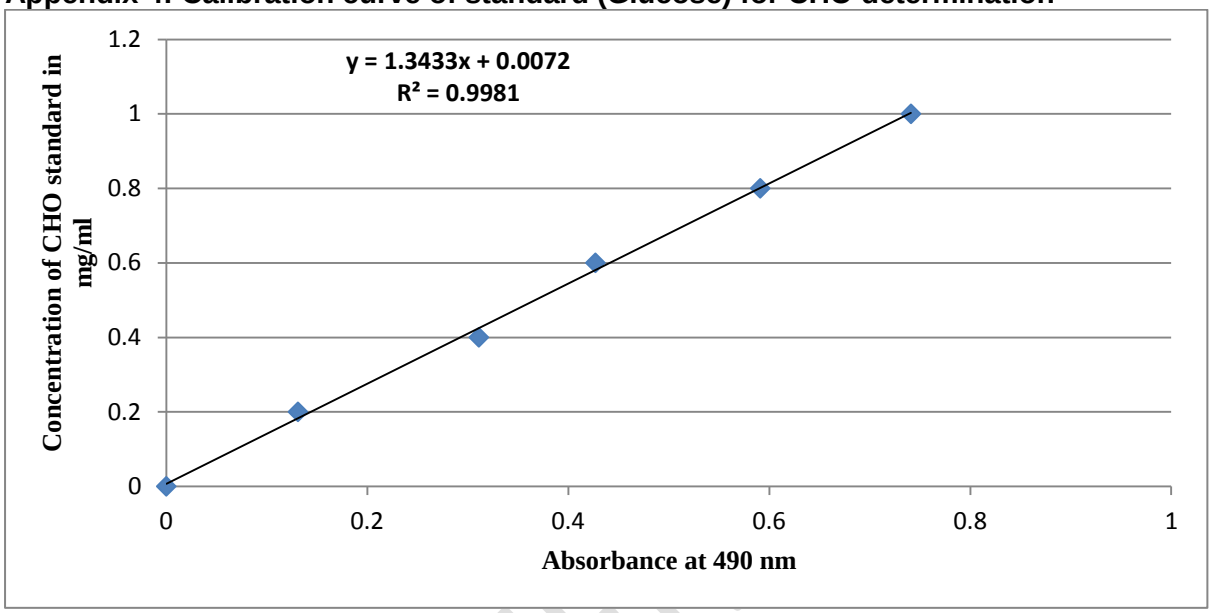
Sl. No.	pH	Titratable Acidity	Total Soluble Solid	Vitamin-C
Between	0.082^{NS}	0.017^{NS}	81.564**	17.806**

Within	0.037	0.016	0.056	0.018

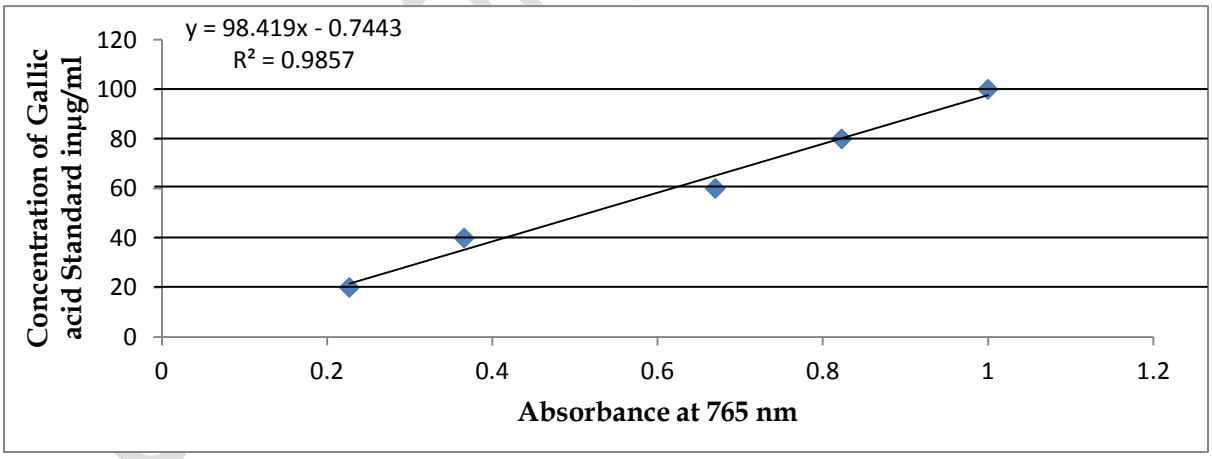
Appendix 3: Analysis of variance (ANOVA) of chemical characteristics of sapota

Sl. No.	Carbohydrate	Anthocyanine	carotenoids	Phenolic Contents	Antioxidants
Between	85.426**	.376**	7.009	.765	52.139
Within	2.715	.004	0.010	0.001	0.001

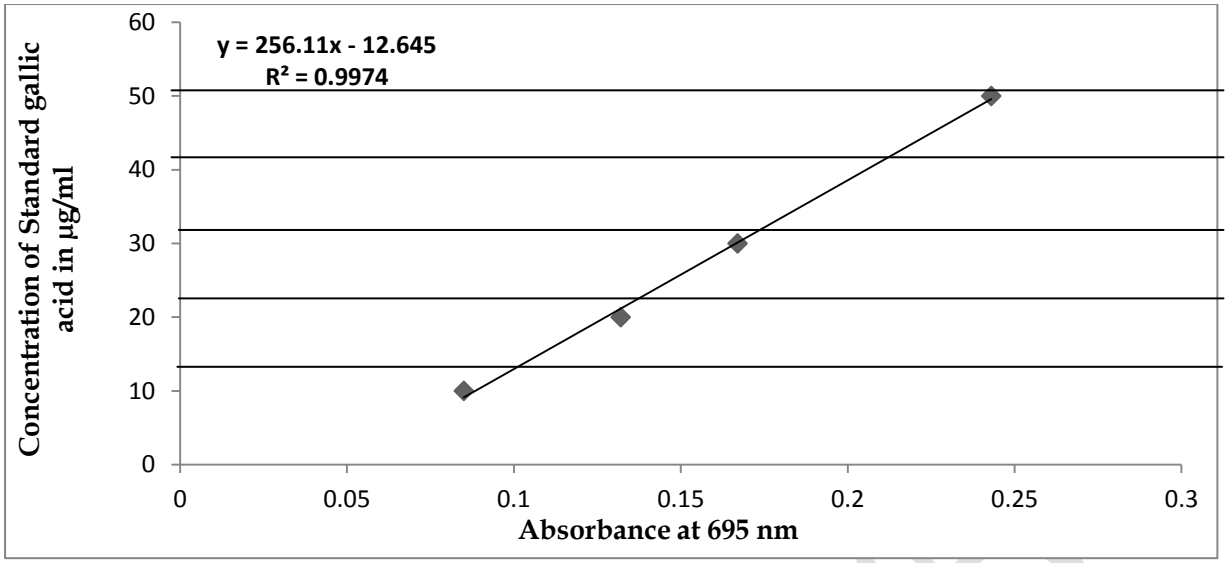
Appendix 4: Calibration curve of standard (Glucose) for CHO determination



Appendix 5: Calibration curve of Gallic acid standard for total phenolic content (TPC)



Appendix 6: Calibration curve of Gallic acid standard for total antioxidant capacity determination



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