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Characterization of fruits of eleven accessions of jackfruit

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Abstract
An investigation was carried out to study the characterization of eleven accessions of jackfruit at five different harvesting times. Eleven accessions were taken to study the physical characteristics and chemical characteristics. It was conducted at the BAU-GPC, Bangladesh Agricultural University, Mymensingh during the period from March to December. Physical characteristics of fruit such as weight of fruit, bulb, seed, rind and axis; skin colour, number of bulbs per fruit, nature, flavour and sweetness of bulbs and chemical characteristics such as total soluble solids, moisture, dry matter, TSS, pH, Titrable acidity, Ascorbic acid, Reducing sugar, Non reducing sugar, Total sugar contents of jackfruit bulbs were determined. Fruits were harvested at five different time, namely very early harvesting (25 May), early harvesting (4 June), mid harvesting (14 June), late harvesting (24 June) and very late harvesting (4 July). General observations on the physical characteristics of fruits such as texture, fibrousness, juiciness, flavour and sweetness of bulbs were taken at different harvesting time. Weight of fruit, weight of edible and non-edible portions also varied at five different harvesting. Total soluble solids contents were found to be the highest at early harvesting time and the lowest at late harvesting time. Early and mid-harvesting time was found to be better in all accession of jackfruit. Accession number Ah3 was found to be the best in respect of fruit, pulp and seed characteristics, which was followed by Ah1, Ah2, Ah12, Ah15, Ah18 and Ah27. A wide variation in the moisture, dry matter, TSS, pH, Titrable acidity, Ascorbic acid, Reducing sugar, Non reducing sugar, Total sugar contents was observed in the bulbs of eleven accession of jackfruit types considered in the present investigation. The results of the study are helpful for attempting crop improvement and selection of superior desirable jackfruit genotypes for bringing to cultivation.

Keywords: Fruits, BAU-GPC, Bangladesh, physical characteristics

Introduction
Jackfruit (*Artocarpus heterophyllus* L.) is the national fruit of Bangladesh. It is one of the important and popular fruits in Bangladesh (Haque, 1977) [3]. Jackfruit is considered to be the largest fruit in the world (Naik, 1949; Sturrock, 1959) [6, 9]. In Bangladesh, it ranks second in production and third in area among the fruits. It is a member of the family Moraceae. The family comprises of 55-67 genera and 900-1000 species (Bally, 1949). The genus Artocarpus contains eight species which bear edible fruit.

The production of jackfruit in Bangladesh was 267495 tons, from an area of 66,765 hectares (BBS, 2012) [1]. Jackfruit is cultivated in Bangladesh from time of immemorial and it is distributed throughout the country. It seems to be originated from the Western Ghats of India (Samaddar, 1990) and then spreaded to Malaysia and East Africa (Dutton, 1976). At present it is cultivated in Bangladesh, India, Burma, Southern China and to a limited extent in Queensland (Australia) and Mauritius (Morton, 1965). The jackfruit grows well in Dhaka, Mymensingh, Rangpur and Jessore regions of the country.

Jackfruit is considered as a multipurpose fruit tree because each and every part of it is utilized. Pulp of the fruit is eaten fresh and tender fruit is also used as a popular vegetable. Ripe fruit also can be used as syrup, jam, beverage, candies and other hydrated form in industry (Naik, 1949) [6]. Bulb of young fruit contains 11.9% protein (dry), 58% carbohydrate (dry), 4.7% minerals (total) and 0.014% vitamin-C whereas the ripe fruit contains 4.8% protein (dry), 82.5% carbohydrate (dry), 82.4% sugar (total) and 3.5% minerals (total) vitamin C and A (0.007% and 0.1%). (Azad and Haq., 1999). The fruit also contain 250-1740 µg carotene per 100 g pulp (Hossain and Haque, 1979).

Jackfruit seed is also an important part of the fruit. Raw seeds are used as a vegetable in Bangladesh. It also helps in digestion after heavy eating of jackfruit pulp (Kamaluddin, 1966). Roasted seeds are very tasty. The seeds are also used in bakery, canned and biscuit. Timbers are used in making quality furniture and as building materials. Rind of the fruit is an excellent cattle feed. Green leaf is a popular fodder, particularly for goats in the rainy season. Its resinous latex is used to plug the holes of the earthenware.

Skin and core of fruits can be used for pectin extraction (Vilashchandran *et al*., 1982). Plants can be used as a living support for black pepper and coffee plants. Now a day it is an important part of the homestead agroforestry program in Bangladesh (Haque, 1994).

The farmers of our country are not able to know which type of jackfruit is demandable for export, which is the actual time of harvesting of different types of jackfruit. The growers are also not aware what kinds of jackfruit are used in industries and which ones are used for normal purposes. Knowledge on physical and chemical characters of different types of jackfruit will help the growers to identify actual characters of quality jackfruit for using different purposes.

Materials and Methods

Study Area: This experiment was conducted at the BAU-GPC of Fruit Tree Improvement Project (FTIP) of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh from March to December. Biochemical analysis was done in the department of Biochemistry & Molecular biology, BAU, Mymensingh.

According to the management practices, the experiment consists of two factors with three replications. These are following:

Factor A: It consists of eleven accessions of jackfruit tree. i.e; Ah_1, Ah_2, Ah_3, Ah_{12}, Ah_{14}, Ah_{15}, Ah_{18}, Ah_{19}, Ah_{26}, Ah_{27} and Ah_{68}.

Factor B: six management practices

Very early harvesting of different accessions: Very early harvesting was collected 25 May and accession no. Ah_2, Ah_3, Ah_{15} and Ah_{26} harvested on this day.

Early harvesting of different accessions: Early harvesting had been done in 4 June and accession no. Ah_1, Ah_2, Ah_3, Ah_{12}, Ah_{15} and Ah_{19} were harvested on this day.

Mid harvesting of different accessions: Mid harvesting had been done in 14 June and accession no. Ah_1, Ah_2, Ah_3, Ah_{12}, Ah_{14}, Ah_{15}, Ah_{26}, Ah_{27} and Ah_{68} were harvested on this day.

Late harvestingof different accessions: Late harvesting had been done in 24 June and accession no. Ah_2, Ah_{12}, Ah_{14}, Ah_{18}, Ah_{26}, Ah_{27} and Ah_{68} were harvested on this day.

Very late harvestingof different accessions: Very late harvesting had been done in 4 July and accession no. Ah_2, Ah_{12}, Ah_{14}, Ah_{15}, Ah_{18} and Ah_{68} were harvested on this day.

Physical Characteristics and TSS of different accession of different fruits ripened in different days. Different characteristics were selected from ripened fruits. Organoleptic test was also Accessions were selected from BAU-GPC, BAU, Mymensingh, on the basis of number of fruits per plant and fruit size.

Conducted in the laboratory of the Department of Horticulture, BAU, Mymensingh by the teachers and postgraduate students of this department. After ripening, photographs were also taken for different parts of fruits of 1l accessions of jackfruit.

Physical characteristics: The physical characteristics that were observed are given below:

Weight of fruit: Fruit was weighed after ripening. The weight was taken by electric balance and expressed in kilogram (kg).

Fruit size: The length and breadth of fruits were measured by a tape and expressed in cm.

Placing jackfruit for ripening: The collected jackfruits were placed in an air tight room for ripening. Care also taken to avoid rotting and intensive observation was conducted to identify the ripen fruit by pressing with finger and smell.

Number of bulb and seeds per fruit: The number of bulbs and seeds were also counted.

Weight of different parts of the fruits: Weight of pulp, seed, rind and rachis were taken by a electric balance and expressed in kilogram (kg).

Total soluble solids (TSS): Total soluble solids (TSS) was determined by refractometer. A drop of juice squeezed from the jackfruit bulb was placed on the prism of the refractometer and percent total soluble solid was obtained from reading. Temperature corrections were made as described by Ranganna (1994).

Moisture: Ten gram of the pulp of jackfruits was taken in porcelain crucibles and placed on a steam bath for 12 hours for evaporation. The porcelain crucibles with its contents were transferred to an oven maintained at a constant temperature of 800C for about 72 hours until the weight becomes constant. The crucibles with the sample was then transferred to a desicator containing anhydrous calcium chloride and kept there for about 8 hours.

The final weights were then taken. Percent moisture content was calculated according to the following formula-

$$\%Moisture = \frac{IW - FW}{IW} \times 100$$

Where, IW, FW represents initial weight of pulp and final weight of oven dried pulp.

Dry matter: Percentage of dry matter of the pulp was calculated from the data obtained during moisture estimation using the following formula:

% Dry matter = 100 -% moisture content.

Total soluble solids (TSS): Total soluble solids (TSS) was determined by refractometer. A drop of juice squeezed from the jackfruit bulb was placed on the prism of the refractometer and percent total soluble solid was obtained from reading. Temperature corrections were made as described by Ranganna (1994).

pH: One gram of fruit juice was homogenized in 1ml of boiled water and 1ml of demonized water of pH 7.0 and the pH was recorded by using a pH meter.

Titratable acidity: The titratable acidity of jackfruit pulp was determined by the method of Ranganna (1994). The following reagents were used for the determination of titrable acidity.

- Standard NaOH solution (0. 1N)
- 1% phenolpthalein solution

Extraction of jackfruit juice: Ten gram of fresh jackfruit pulp was taken in 100 ml beaker and then it was homogenized with distilled water in blender. The blending materials were then filtered and transferred to a 100 ml volumetric flask and the volume was made up to the mark with distilled water.

Procedure:10ml of pulp solution was taken in a conical flask. Two to three drops of phenolpthalein indicator was added and then the conical flask was shaken vigorously. It was then filtrated immediately with 0.01 N NaOH solution from a burette till a permanent pink colour was appeared. The volume of NaOH solution required for titration was noted from burette reading. Percent titratable acidity was calculated by using the following formula

$$\%Tritatable\ acidity = \frac{T \times N \times V_1 \times E}{V_2 \times W \times 1000} \times 100$$

Where, T, N, V_1, E, V_2, W represents titre, normality of NaOH, volume made up, Equivalent weight of acid, Volume of extract, Weight of sample.

Sugar in fruit pulp: Sugar content of fruit pulp was estimated by determining the volume of unknown sugar solution in fruit pulp required complete reduction of standards Fehling's solution. The following procedures were- followed in determining the sugar content of fruit pulp (Lane and Eynon, 1923).

Standardization of Fehling's solution: 50ml of both Fehling's solution A and Fehling's solution B were Mixed together in a beaker. Ten ml of solution, was pipetted into a 250 ml conical flask and 25 ml distilled water was added to it. Standard sugar solution was taken in burette. The conical flask contaning mixed solution was heated on a hot plate. When the solution began to boil, three drops of methylene blue indicator solution A-as added to it without removing the 11ask from the hot plate. Mixed solution was titrated by standard sugar solution. The end point was indicated by decolorization of indicator. Fehling's Factor was calculated by using the following formula

$$Fehling's\ Factor\ (g\ of\ invert\ sugar) = \frac{Titre \times 25}{1000}$$

Preparation of sample: Twenty gram of fresh fruit pulp was taken in a beaker in blender machine and homogenized with distilled water. Then the blended material transferred to a 250 ml volumetric flask. The Volume was made up to tile niark with distilled water. The pulp was filtered. One hundred ml of filtrate was taken in a 250 ml volumetric flask. Five nil of 45% neutral lead acetate solution was added to it and then shaken and waited for 10 minute. Five ml of 22% potassium oxalate solution was further added to the flask and the volume was made up to the mark with distilled water and filtered.

Titration of reducing sugar:10ml of mixed Fehling's solution was taken in a 250 ml conical f1ask and 50 ml distilled water added to it. Purified pulp solution (filtrate) was taken in burette. Conical flask containing the mixed Fehling's solution was heated on a hot plate. Three to five drops of methylene blue indicator were added to the flask when boiling standard titrate. D with solution taken in the burette. The end point was indicated by decolorization of indicator. Percentage of reducing sugar was calculated according to the following formula:

$$\%\ Reducing\ sugar\ content\ of\ fruit\ pulp = \frac{F \times D \times 100}{T \times W \times 1000}$$

Where, F, D, T and W represents Fehling's Factor, dilution, titre and weight of the sample respectively.

Titration of total sugar: 50ml of purified (filtrate) was taken in 250 ml conical flask. 5 ml of citric acid and 50 ml distilled water were added to it. The conical flask containing sugar solution was boiled for inversion of sucrose and finally cooled. Then the solution was transferred to a 250 ml volumetric flask and neutralized by 1 N NaOH using phenolphthalein indicator. The volume was made up to the mark with distilled water. Then the mixed Fehling's solution was titrated using similar procedure followed as in case of invert sugar (reducing sugar) mentioned earlier. Percent invert sugar was calculated by using the formula used in case of reducing sugar.

Estimation of non-reducing sugar

% Non-reducing sugar =% Total invert sugar -% reducing sugar

Estimation of total sugar

% Total sugar =% Reducing sugar +% Non-reducing sugar

Statistical analysis: The recorded data on different parameters of the study were analyzed statistically using MSTAT computer package program. Analysis of variance of different parameter was performed by (F) variance test. The mean differences were performed by Least Significance Difference (LSD) test at 1 and 5 percent of probability.

The data collections were done based on the following points: individual fruit weight, individual fruit size, weight of rachis, weight of rind, weight of seed, number of seeds per fruit, viviparous germination of seed and total soluble solids (TSS). The collected data were analyzed by a statistical programme MSTAT-C following the appropriate design of the experiment (Gomez and Gomez, 1984). The means for all the treatments were calculated and the analysis of variance (ANOVA) for most of the characters under consideration were performed by the least significance difference (LSD) test taking the probability level 1% as the maximum unit of significance.

Results and Discussion

Physical characteristics of different accessions:

Fruit Weight: Fruit weight was significantly affected by harvesting times. It was observed at the mid-term harvesting Ah27 accession gave maximum average fruit weight (8.16kg), while it was minimum (4.90kg) at the late harvesting. The present results are close to the findings of Azad (1998) who reported that fruits of the early seasons were larger (7.1 kg) while those in the late seasons were smaller (4.6).

Size of Fruit: The result on the study of size (length x breadth) of different accessions of jackfruit at different harvesting times are shown in Tables 1-5. Among the different harvesting times, mid harvesting of accession no. Ah27 fruit gave maximum average fruit length (54.76 cm), breadth (28.52 cm) while it was minimum at very early harvesting time. The present result, are close to the findings of Bhatia *et al*. (1955) and Mowry *et al*. (1953) who reported that the fruits to be 20.32 to 91.44 cm long and 15.24 to 50.80 cm wide. Hossain and Haque (1977) [3] stated that the mean length and diameter of fruits were 31.6 and 22.4 cm.

Weight of Fruit Rachis: It was observed that the early harvesting time had maximum weight of rachis while it gradually decreased with the delay harvesting times.

Weight of Fruit Rind: The rind weight of jackfruit was also influenced significantly by harvesting times of different accessions. Mid-harvesting produced the maximum weight of rind (3.18 kg) in Ah15 accession while the minimum (1.81 kg) in Ah2 accession was found at the early harvesting time.

Bulb of Weight: The results showed that the harvesting times had significant variation in respect of bulb of weight Mid-term harvesting had comparatively greater bulb of weight (4.06 kg) in accession no. Ah27 than that of early and late harvesting time.

Weight of Seed: Analysis of variance showed that seed of weight of fruits harvested at different times was significantly different. The maximum seed of weight (0.730 kg) was obtained from accession no. Ah3 fruits at mid harvest and the lowest (0.510 kg) was found in accession no. Ah19 in early harvest. Manjunath (1948) also reported that the seeds composed about 5.1 percent of the total weight of the fruit.

Number of Bulbs: per fruit at different harvesting times in the present study insignificant variation was found in number of bulbs among the different harvesting times of different accessions (Table 2). The maximum number of bulbs (107) was shown at mid harvest. The lowest number of bulbs (80) was shown at very early harvesting. Mid harvesting gave maximum number of bulbs of different accessions gave good quality of fruit. But very early harvesting and very late harvesting was given minimum number of bulbs of different accessions.

Number of Viviparous Seed: Analysis of variance showed that the harvesting time had significant influence on the percentage of viviparous seed (Table 4-5). The maximum number of viviparous seed (12.33) was found by accession no. Ah18 and minimum (5.33) was found in Ah14 in late harvesting time. The highest number of viviparous seed (15.00) was found by accession no. Ah14 and minimum (8.66) was found in Ah12 in very late harvesting time. Azad (1989) reported that jackfruit plants produced fruit having 46.50% viviparous seed at late season or late harvest. He stated that viviparity might be varietal characters in association with late harvest. Habib (1973) also reported 41.97% viviparous seed in the ripe fruit of jackfruit. Karim (1997) observed that the percentage of viviparous seeds (59.44%) was found in late harvested and no viviparous was found in early harvested jackfruit.

Total Soluble Solid (TSS): There was no significant difference in total soluble solids content of bulb due to the harvesting times. The total soluble solids in bulbs of jackfruit ranged from 18.8 - 26.00. Haque (1993) [2] found that the total soluble solids in green jackfruit was 18% and 20% in ripe jackfruit bulb. Total soluble soilds content observed in the present study agreed with the above report. There was no significant variation in total soluble solids contents among the accessions (Table 1).

Table 1: Very early harvesting of fruits of different accessions

Accession No.	Size of fruit		Weight of rachis(kg)	Weight of rind(kg)	Weight of bulbs without seed(kg)	Weight of seed(kg)	TSS(%)
	Length (cm)	Breadth (cm)					
Ah_2	54.14	25.69	0.617	2.39	3.04	0.660	13.66
Ah_3	45.95	22.23	0.537	1.99	2.15	0.520	13.33
Ah_{15}	44.47	23.43	0.437	2.20	2.82	0.590	15.00
Ah_{26}	51.39	26.90	0.590	2.12	2.38	0.560	16.00
LSD	3.30	2.90	0.063	0.126	0.513	0.089	1.59
LSD	5.00	4.39	0.095	0.191	0.777	0.135	2.42
Level of Sig.	**	**	**	**	**	*	**
CV%	3.37	5.92	5.80	2.74	9.14	7.33	5.51

** = Significant at 1% level of probability
* = Significant at 5% level of probability

Table 2: Early harvesting of fruits of different accessions

Accession No.	Size of fruit		Weight of rachis(kg)	Weight of rind(kg)	Weight of bulbs without seed(kg)	Weight of seed(kg)	TSS(%)	No of seeds/fruit
	Length (cm)	Breadth (cm)						
Ah_1	47.82	26.00	0.513	2.33	3.23	0.563	18.66	74.66
Ah_2	42.89	27.68	0.420	1.81	2.67	0.547	17.66	76.66
Ah_3	48.87	27.77	0.563	2.32	2.95	0.610	18.66	85.33
Ah_{12}	46.97	27.51	0.647	2.66	3.61	0.723	17.33	100.66
Ah_{15}	44.22	24.96	0.584	1.99	2.94	0.603	17.33	87.33
Ah_{19}	44.80	24.15	0.460	2.11	3.26	0.510	15.66	73.66
LSD0.05	2.60	1.38	0.115	0.340	0.335	0.115	0.168	11.11
LSD0.01	3.70	1.96	0.163	0.484	0.477	0.163	2.39	15.81
Level of sig	**	**	**	**	**	*	**	**
CV%	3.12	2.88	11.57	7.76	5.54	10.87	5.27	7.36

** = Significant at 1% level of probability
* = Significant at 5% level of probability

Table 3: Mid harvesting of fruits of different accessions

Accession No.	Size of fruit		Weight of rachis (kg)	Weight of rind (kg)	Weight of bulbs without seed (kg)	Weight of seed (kg)	TSS(%)	No of seeds/ fruit
	Length (cm)	Breadth (cm)						
Ah_1	48.49	27.84	0.597	2.35	2.51	0.607	26.66	77.33
Ah_2	52.30	26.35	0.563	1.97	2.92	0.623	27.66	73.00
Ah_3	51.60	27.25	0.547	2.34	3.68	0.730	24.33	76.33
Ah_{12}	53.86	24.86	0.657	2.30	3.40	0.700	23.00	94.33
Ah_{14}	45.36	27.75	0.623	2.38	2.62	0.630	26.00	84.33
Ah_{15}	52.11	26.50	0.923	2.88	3.75	0.610	24.66	100.00
Ah_{26}	52.94	23.70	0.610	2.30	2.92	0.617	24.33	77.33
Ah_{27}	54.76	28.52	0.660	3.04	3.76	0.673	23.66	100.66
Ah_{68}	45.23	26.54	0.590	1.94	2.89	0.590	25.33	73.66
$LSD_{0.05}$	3.49	1.98	0.144	0.394	0.470	.0054	2.32	9.78
$LSD_{0.01}$	4.81	2.73	0.199	0.543	0.648	0.075	3.21	13.49
Level of sig	**	**	**	**	**	**	**	**
CV%	3.98	4.30	13.24	8.51	7.76	4.43	5.37	6.72

** = Significant at 1% level of probability
* = Significant at 5% level of probability

Table 4: Late harvesting of fruits of different accessions

Accession No.	Size of fruit		Weight of rachis (kg)	Weight of rind (kg)	Weight of bulbs without seed (kg)	Weight of seed (kg)	TSS (%)	No of seeds/fruit	No. of viviparous seed
	Length (cm)	Breadth (cm)							
Ah_2	49.22	35.17	0.440	1.997	2.913	0.657	27.66	69.66	6.66
Ah_{12}	43.41	24.20	0.433	1.573	2.380	0.513	27.00	68.00	6.00
Ah_{14}	47.84	28.49	0.483	1.883	2.853	0.577	27.00	75.00	5.33
Ah_{18}	47.78	32.49	0.573	2.087	3.143	0.663	25.66	78.00	12.33
Ah_{26}	46.66	22.60	0.453	2.010	2.503	0.527	26.00	72.33	6.00
Ah_{27}	51.67	26.20	0.623	2.293	2.773	0.643	26.33	79.66	6.66
Ah_{68}	53.35	35.14	0.520	2.437	3.520	0.597	27.33	71.66	6.33
$LSD_{0.05}$	4.35	3.32	0.078	0.276	0.734	0.095	1.55	4.49	0.857
$LSD_{0.01}$	6.04	4.61	0.108	0.384	1.02	0.133	2.15	6.23	1.19
Level of sig	**	**	**	**	**	*	*	**	**
CV%	5.14	6.61	9.36	6.65	12.89	9.32	3.29	3.47	6.68

** = Significant at 1% level of probability
* = Significant at 5% level of probability

Table 5: Very late harvesting of fruits of different accessions

Accession No.	Size of fruit		Weight of rachis (kg)	Weight of rind (kg)	Weight of bulbs without seed (kg)	Weight of seed (kg)	TSS (%)	No of seeds/fruit	No. of viviparous seed
	Length (cm)	Breadth (cm)							
Ah_2	44.03	24.83	0.550	2.25	2.15	0.550	24.66	65.66	13.66
Ah_{12}	46.23	23.94	0.600	2.39	2.47	0.600	23.66	71.66	8.66
Ah_{14}	42.38	23.41	0.537	2.08	2.20	0.537	23.66	69.66	15.00
Ah_{15}	50.66	25.17	0.593	3.16	2.84	0.593	23.00	76.00	11.33
Ah_{18}	44.57	24.61	0.557	2.37	2.12	0.557	24.33	61.66	10.33
Ah_{68}	43.54	24.62	0.557	2.38	2.07	0.557	22.33	63.66	12.66
$LSD_{0.05}$	3.82	1.02	-	0.560	0.354	-	1.07	4.95	0.53
$LSD_{0.01}$	5.43	1.46	-	0.797	0.504	-	1.52	7.04	5.03
Level of sig	**	*	NS	*	**	NS	**	**	**
CV%	4.64	2.32	10.44	11.66	7.77	8.90	2.50	4.00	16.30

** = Significant at 1% level of probability
* = Significant at 5% level of probability

Chemical characteristics: The chemical characteristics of jackfruit pulp of different Accessions are presented in Table 6.

Moisture content: Moisture content of bulb was significantly affected by harvesting times. The percentage of moisture content was decreased as the harvesting delayed. The bulb of early harvested fruit had maximum moisture content (79.39%) was found in accession no. Ah18 while it was minimum (68.51%) was found in accession no. Ah19. Purseglove (1968) and Sturrock (1959) [9] had reported the moisture content of bulb as 73.1 and 81.08% respectively. Thus the present results were found to be closer to the findings of Sturrock. There was significant difference in percentage of moisture due to selections (Table 1). Karim (1997) observed moisture contents of 80.40% and 78.34% in early and late harvesting jackfruit, respectively. Purseglove (1968) and Sturrock (1959) [9] also found similar results of moisture content in jackfruit pulp.

Dry matter content: Dry matter content was also different in different Accessions. The highest (31.49%) was found in Ah19 and the lowest (21.34%) was in Ah2. Data on changes in dry matter content of different accessions derived from percentage of moisture content are shown in Table 1. The results showed that there were gradual increases in dry matter content from early harvesting to late harvesting. There were no significant variations in dry matter contents among the accessions. Karim (1997) reported that dry matter content generally increased from early to late harvesting time.

Total soluble solids (TSS): Total soluble solids (TSS) contents were found different in different Accessions of jackfruit. It ranged from 18.88 to 26.00%. The highest (26.00%) was recorded in Ah68 and the lowest (18.88%) was in Ah3. There was no significant difference in total soluble solids content of bulb due to the harvesting times. Haque (1993) [2] found that the total soluble solids in green jackfruit was 18% and 20% in ripe jackfruit bulb. Total soluble soilds content observed in the present study agreed with the above report. There was no significant variation in total soluble solids contents among the accessions (Table 1).

pH

There were little differences in pH content of different Accessions of jackfruit. It was around 5. But the highest (5.82) was recorded in Ah15 and the lowest (5.0) was in Ah19. There was no significant difference in pH due to the harvesting times (Table 1). Present results showed that the pH of juice of bulb at different harvesting times were in the range from 5.00 to 5.82 (Table 1).

Table 6: Chemical composition of jackfruit pulp of different accessions

Accession No.	Moisture (%)	Dry matter (%)	TSS Brix (%)	pH	Titrable Acidity (%)	Ascorbic acid	Reducing sugar	Non reducing sugar	Total sugar
Ah1	77.40	22.60	22.50	5.17	0.16	5.05	7.90	12.41	20.31
Ah2	78.60	21.40	21.84	5.36	0.18	4.85	5.96	13.42	19.38
Ah3	76.53	23.47	18.88	5.08	0.17	5.07	5.40	9.71	15.31
Ah12	73.61	26.39	22.75	5.10	0.19	4.93	6.41	11.56	18.07
Ah14	77.70	22.30	22.55	5.30	0.16	4.97	8.06	9.74	17.80
Ah15	75.32	24.68	20.41	5.82	0.11	5.04	5.06	8.32	13.38
Ah18	79.39	20.61	24.00	5.03	0.17	5.02	8.21	12.61	20.82
Ah19	68.51	31.49	20.83	5.00	0.19	4.99	5.06	5.92	10.98
Ah26	76.31	23.69	22.22	5.18	0.16	4.87	6.43	9.96	16.39
Ah27	78.49	21.51	25.50	5.09	0.15	4.78	6.95	11.09	18.04
Ah68	74.17	25.83	26.00	5.71	0.13	5.01	6.73	11.30	18.03
LSD0.05	1.04	0.844	0.519	0.152	0.017	0.186	0.274	0.420	0.630
LSD0.01	1.42	1.15	0.708	0.207	0.023	0.254	0.374	0.573	0.859
Level of significance	**	**	**	**	**	**	**	**	**

Titratable acidity (%): A little variation was observed in titratable acidity content of different Accessions. But it was not exceed in 0.19%. Among them the highest (0.19%) was found in Ah14, Ah19 and the lowest (0.11%) was in Ah15.

Ascorbic acid: Ascorbic acid was found different in different accessions and it was varied from 4.85 to 5.07. The highest ascorbic acid (5.07) was recorded in Ah3 and the lowest ascorbic acid (4.78) was found in Ah27. The maximum vitamin C content (5.07 mg/100g) was obtained from Ah3 and the minimum (4.48 mg/100g) was in Ah27 (Table 1). Hossain and Haque (1979) stated that average ascorbic acid content of the bulb was 5.56 mg/100g. There is no significant variation in Vitamin C content among the selections.

Reducing sugar content (%): The percentage of reducing sugar was different in different Accessions. It was observed that Ah18 had the maximum (8.21%) percentage of reducing sugar of jackfruit bulb while the minimum (5.40) percentage of reducing sugar of jackfruit bulb was found in Ah3 (Table 1).

Reducing sugar content was gradually decreased with the delaying of harvesting time. There was no significant difference in percentage of reducing sugar due to selections (Table 1). Karim (1997) also reported that reducing sugar content was the highest in early and the lowest was in the late harvested jackfruits

Non-reducing sugar content (%): Non reducing sugar content was also found in different in different accession. The percentage of non reducing content observed between 5.92 and 13.42%. The highest percentage of non-reducing sugar content was obtained from Ah2 (13.92%) and the lowest (5.92%) was found in Ah19 (Table 1). Karim (1997) also found non reducing sugar content ranged from 7.17 to 9.04%.

Total sugar content (%): The maximum percentage of total sugar was found in bulb of accession no. Ah18 (20.82) (Table 1) while it was the minimum in Ah19 (10.98). Haque (1993) [2] reported sugar content in ripe fruit to be 15% while Hossain (1976) [4] had reported a wide range from 15.38 to 26.30%. The present results are in the range mentioned by the later. There was no significant difference in percentage of total sugar content (Table 1). Total sugar content depends on harvesting time and 18.18% was found in early and 13.93% in the late harvested jackfruit pulp (Karim, 1997).

Conclusions

An investigation was carried out to study the physical characteristics of eleven accessions of jackfruit at five different harvesting time. Eleven accessions were taken to study the physical characteristics and chemical characteristics. On the basis of physical characteristics the best accession Ah2, Ah12, Ah27, Ah68 and Ah15 in the very early, early, mid, late and very late harvesting. From the above results it may be concluded that among the eleven Accessions the best Accession was Ah3 in respect of physical characteristics. Jackfruit, being highly cross pollinated and mostly seed propagated exists in innumerable types or forms, with different fruit characteristics. These chemical characteristics measures the variability of different types of jackfruit. Accession no. Ah19 was the best in respect of chemical characteristics. The results of the study are helpful for understanding the variability and attempting the selection of superior desirable jackfruit genotypes for bringing to commercial cultivation.

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