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EFFECT OF HARVESTING TIME AND VARIETIES ON THE PHYSICOCHEMICAL CHARACTERISTICS OF JACKFRUITS (*Artocarpus Heterophyllus* Lam.)

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ABSTRACT

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An investigation was carried out at the Horticulture farm of Bangladesh Agricultural University to study the physicochemical characteristics of jackfruit at three different harvesting times. Physical characteristics of fruit such as weight of fruit, bulb, seed, rind and axis; skin color, number of bulbs per fruit; nature, flavor and sweetness of bulbs, and chemical characteristics such total soluble solid (TSS), pH, sugar, vitamin C, moisture, dry matter, ash contents of jackfruit bulbs were determined. Matured jackfruits were harvested at three different times, namely early harvesting, mid harvesting and late harvesting and observed that texture, fibrousness, juiciness, flavor and sweetness of bulbs were changed at different harvesting time. Weight of fruit, weight of edible and non-edible portions were also varied at three different harvesting times. Dry matter, ash and non-reducing sugar contents of bulbs were gradually increased with the harvesting times from early to late in the season. At early harvesting time dry matter, ash and non reducing sugar contents were found to be the lowest and the highest at late harvesting time. On the other hand, TSS, vitamin C, moisture, total sugar, reducing sugar, contents of jackfruit bulbs decreased during the time. Again TSS, vitamin C, moisture, total sugar, reducing sugar, non-reducing sugar contents were found to be the highest at early harvesting time and the lowest at late harvesting time.

Keywords: Jackfruit, harvesting time, physiochemical characteristics

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus*) is one of the most popular and indigenous fruit crop as well as national fruit of Bangladesh. It is grown in Bangladesh, Burma, India, Indonesia, Malaysia, the Philipines, Sri Lanka, Thiland and to some extent in Brazil and Queensland (Australia). It is cultivated in Bangladesh from time immemorial. It is grown through out the country; usually in high land and homestead areas where rain or floodwater does not stand. There are 24925 hectares of land under jackfruit producing 254660 tons of fruits annually in Bangladesh (BBS, 2006). In terms of production it ranks second among the fruit crops of Bangladesh.

It is generally found that the texture of bulbs become crispy when the fruits harvested in late part of the season. Juiciness is reduced and it turns into insipid in taste. Flavor of the fruit is also degraded from good to average and sometimes develop bad smell. The size and shape of the fruit varies with the time of harvesting. Early season fruits are nearly regular, uniform in shape but the fruit of the late season are mostly irregular. The seeds at the late harvest are found to be viviparous (Azad, 1989), when viviparity occurs inside the fruit, the seeds are lost their roasting or boiled quality and become tasteless.

Bangladesh is a rich source of variable germplasm of jackfruit; primarily due to universal practice of seed propagation employed with this fruit. The information on the Physical characteristics of fruit is important to know the quality of fruit at different harvesting times of the season. This will help the jackfruit grower to determine optimum time of harvesting of fruit and to get good price of their produce/ commodity in the market.

In above context, a study on the qualitative characteristics of jackfruits in relation to harvesting times has been undertaken.

MATERIALS AND METHOD

The investigation was carried out at the Horticulture Farm of Bangladesh Agricultural University (BAU), Mymensingh, in a Randomized Complete Block Design with 3 selected clones of Jackfruit viz. Selection 1, Selection 2 and Selection 3. Harvesting times and selections served as factors. The selected plants were ghila type. The selected clones of jackfruit produced flowers in the third week of December to first week of March. Mature jackfruits were harvested at different time, namely early harvesting time was done on 31 May, mid harvesting time on 25 June and late harvesting time on 20 July. Three fruits were collected from each selected plant in each harvesting time. The collected fruits of three clones were brought to the laboratory. The laboratory

facilities of the Department of Food Technology and Rural Industry and Horticulture were used to determine the qualitative characteristics of jackfruit at three different times of harvesting.

Physical characteristics

Physical characteristics such as weight of fruit (kg), size, shape (expressed in language as made by Jagirdar and Maniyar, (1960), rind (%), seed axis (%), bulb (%), number of bulbs per fruit, flavour, sweetness of the bulb (fully developed pericarp), and number of viviparous seeds were studied.

Chemical characteristics

The methods utilized for the estimation of moisture and dry matter (weight basis), ascorbic acid, total soluble solid (TSS), pH, total sugar, reducing sugar, non-reducing sugar and ash were those of A.O.A.C. (1965) and Lane and Eynon (1923). The data were analyzed on fresh weight basis for each value of nutrient.

Ash

Twenty grams of the bulbs of jackfruits were taken in porcelain crucibles and placed into a Muffle furnace at a constant temperature of 650^0C for 4 hours. The crucibles with the sample was cooled and transferred into a desiccators containing anhydrous calcium chloride and it stand for a period of 8 hours. The final weight was taken and from the final weight ash percent was calculated as follows.

$$\% \text{ Ash} = \frac{A \times 100}{I}$$

Where, A = Weight of ash and I = Initial weight of bulb

Total soluble solids (TSS)

Total soluble solids (TSS) content was determined by Abbe 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 the direct reading. Temperature correction was made as described by Ranganna (1979).

Reducing sugar

Fifty grams of the bulb of jackfruit were homogenized with water and transferred to a 500 ml. beaker. It was neutralized with 0.1N NaOH and than boiled gently for an hour with adding water to keep the volume nearly constant. The content of the beaker was cooled and transferred to a 500 ml. volumetric flask. Two milliliters of lead acetate followed by 1.1 ml of potassium oxalate were added to clear the mixture and then the volume was made to 500 ml. The mixture was filtrate and the filtrate was used to titrate against a measured amount of Fehlings' solution had earlier been titrate with standard invert solution. Percent sugar was calculated as follows:

$$\% \text{ Reducing sugar} = I \times D \times 100 / T \times W \times 1000$$

Where, I = mg of invert sugar required to reduce known volume of Fehling's solution, D = Dilution T = Titer, and W = Weight of the sample.

Total sugar

Sample for estimation of total sugar were prepared according to method already mentioned in the case of reducing sugar. The filtrate was used for the determination of total sugar. Hundred milliliters of NH_2SO_4 was taken in 1500 ml. Erlenmeyer flask containing 100 m^2 filtrate and refused for 6 hours. The hydrolysate was neutralized with the filtrate through Whatman No. 40, filter paper and then titrated against measured volume of Etrenmyenmcyr flask containing 100 ml. filtrate and refused for 6 hours. The hydrolysate was neutralized with and fitrate through Whatman No. 40 filter paper and then titrated against measured volume of Fehling's solution. Percent total sugar was calculated reducing sugar making use of titer value obtained in determination of total sugar after inversion.

Non reducing sugar

Non-reducing sugar content was calculated as follows

$$\% \text{ Non-reducing sugar} = \% \text{ total sugar} - \% \text{ reducing sugar}$$

Ascorbic acid (Vitamin C)

Twenty grams of the bulb of jackfruit were blended in a warming blender containing 100 ml. of 3% HPO_3 (Metophosphoric acid solution) for 5 minute. The dilute sample was filtrated through Whatman No. 40 and final volume was recorded. Ten ml aliquot of the filtrate was pipeted into a small Elenmeyer flask. It was titrated immediately with the solution of 2.6 – dichlorophenol indophenol dye as outlined in the A.O.A.C. (1965). The dye had earlier has been standerdized with vitamin C solution to find an equilibrium factor for dye. The ascorbic acid content of the samples was calculated from the following formula.

mg of vitamin C per 100 g bulbs $= T \times D \times V_1 \times 100/V_2 \times W$

Where, T = Titre, D = Dye factor, V_1 = Volume made up, V_2 = Aliquot of extract taken for estimation,
W = Weight of sample taken for estimation

RESULTS AND DISCUSSION

General physico-chemical characteristics of jackfruit at different harvesting times observed during the study has been briefly mentioned. Some of the data have been expressed in the table(s) for ease of discussion, comprehension and understanding. The results are presented under the following heads.

General observation on the physicochemical characteristics of jackfruits at different times of harvesting

Data on physicochemical changes at different times of harvesting during the study are presented in Table 1. The textures of jackfruit bulbs were crispy in late season fruits. The shape of the fruit also varied distinctly in different seasons. Early season fruits were nearly regular, uniform in shape but the fruit of the late season were mostly irregular. Fibrousness was changed and become hardy in late season. Juiciness reduced from very juicy to medium juicy and less juicy. Flavor of the fruits degraded from good to average and sometimes bad smell. Fruits of early season were larger in weight while those in the late season were smaller. At the late harvest bulbs were medium sweet to less sweet. There were viviparous seeds observed inside the fruit and thus the fruit quality deteriorated. The viviparous seeds were found to be lost their roasting or boiled quality and became tasteless. Azad (1989) has reported that quality of fruit deteriorates in the late harvesting.

Physical parameter of jackfruit at different times of harvesting

Weight of fruit

Fruit weight was significantly affected by harvesting times. It was observed that the mid – term harvesting gave maximum average fruit weight (7.32 kg), while it was minimum (5.74 kg) in the late harvesting (Table 2). Azad (1989) reported that fruit of early seasons were larger (7.1 kg) while those in the late season were small (4.6 kg). The present results are close to this findings. The weight of fruit was also varied significantly among the selections. Selection-1 had maximum weight (7.91 kg) of fruit, while selection-3 had the minimum (5.14 kg) (Table 3). The interaction effect also had significant response. It was found that early harvesting of selection-1 produced the fruits of biggest size (8.67 kg). The smallest fruit was obtained (4.57 kg) from selection-3 at late harvest (Table 4).

Weight of bulb

The results showed that the harvesting times had significant variation in respect of bulb weight. Mid–term harvesting had comparatively greater bulb weight (3.13 kg) that of early and late harvesting time (Table 2). The bulb weight of jackfruit also varied among the selections. Selection-1 had maximum weight (3.46 kg), while selection-3 had the minimum 2.02 kg (Table 3). The significant interaction between harvesting times and selection indicated that early harvesting time in association with selection-1 exerted maximum effect on the weight of bulbs (Table 4). Maximum bulb weight 4.42 kg was recorded at early harvesting time in association with the selection-1, while the minimum bulb weight (1.33 kg) was found in Selection-1 when harvested late (Table 4).

Weight of seed

Harvesting times had significantly influence on the weight of seed. The highest seed weight (0.76 kg) was obtained from the early harvesting time and the lowest (0.59 kg) from late harvesting time (Table 2). It appeared that the selection-1 produced the maximum seed weight (0.79 kg), which was significantly different from selection-2 and selection-3 (Table 3). The interaction effects of harvesting time and selection in respect of seed weight ranged from 0.49 kg to 0.94 kg (Table 4) and were significantly different.

Weight of edible portion (Bulb and seed)

It was revealed the results on the weight of edible portion that mid-harvesting time had significantly greater weight than that of the late harvesting time but it was identical with early harvesting time. The maximum weight of edible portion (3.83 kg) of jackfruit was obtained from mid-harvesting time while the minimum weight of 2.58 kg was noted under late harvesting time (Table 2). When considered the selection, it was found that the weight significantly decreased. The maximum (4.25 kg) weight of edible portion was noted in selection-1, while minimum (2.56 kg) in selection-3 (Table 3).

The interaction effect of harvesting time and selection in respect of weight of edible portion was statistically significant. It was clear that early periodic harvest in associated with selection-1 deposited maximum (5.36 kg) weight of edible portion and the minimum was observed (2.17 kg) with the combination of selection-3 and late harvesting time (Table 4).

Weight of fruit axis

Fruit axis content of the jackfruit at different harvesting times exhibited significant variation and was observed that the early harvesting time had maximum weight of axis (0.55 kg) while it gradually decreased with the delayed harvesting times (Table 2). The axis of jackfruit also varied among the selections. Selection-1 had maximum weight (0.52 kg) of axis, while selection 3 showed the minimum (0.40 kg). The significant interaction between harvesting times and selections indicated that early harvesting in association with selection-1 showed maximum weight of axis (Table 4).

Weight of rind

The rind weight of jackfruit was influenced significantly by harvesting times. Mid harvesting produced the maximum (2.37 kg) was found at the early harvesting time (Table 2). The weight of rind was also varied significantly among the selections. It appeared that the selection-1 had the maximum rind weight (3.14 kg) which was significantly different from selections-2 and –3. The significant interaction between harvesting times and selections indicated that mid- harvesting time in association with selection 3 exerted maximum (2.07 kg) with the combination of selection-3 and late harvesting time (Table 4).

Weight of non- edible portion (axis and rind)

The harvesting time had significant influence on the weight of non-edible portion of jackfruit. The maximum weight of non-edible portion (3.48 kg) was found by mid-harvesting time, while the minimum weight of 2.92 kg was noted under the early harvesting time (Table 2). The weight of non-edible portion was varied significantly among the selections. The maximum weight of non-edible portion (3.65 kg) was noted in selection 1, while it was minimum (2.58 kg) in selection 3 (Table 3).The interaction effect of harvesting time and selection in respect of weight of non-edible portion (Table 4) was statistically significant. It was found that mid-term harvest associated with selection 1 deposited maximum (3.90 kg) weight of non-edible portion and the minimum was observed (2.39 kg) with the interaction of selection-3 and the late harvesting time.

Number of bulbs per fruit at different harvesting times

In the present study variation was found in number of bulbs among the different harvesting time of jackfruit (Table 2). The average of 115.00, 109.78 and 88.42 bulbs per fruit was found in early, mid and late harvesting times respectively. Again, there was difference in respect of number of bulbs per fruit among the selection. It appeared that the selection-1 had maximum bulbs (119.oo) which is significantly higher than the selection-2 (106.67) and selection-3 (94.89). Interaction between harvesting times and selection was found to be significant (Table 4).

Percentage of viviparous seed

Analysis of variance showed that the harvesting time had significant influence on the percentage of viviparous seed (Table 2). The maximum percentage of viviparous seeds (59.44%) was found by late harvesting time, while early harvesting time had no viviparous seed. Azad (1989) reported that jackfruit plants produced fruit having 46.5 percent viviparous seed at the late season or late harvest. He stated that viviparity might be variety characters in associated with late harvest. Habib (1973) also reported that 41.97 percent viviparous seed in the ripe fruit of jackfruits. There are no significant variations among the selections (Table 3). The interaction between harvesting times and selections were found to be significant. The highest number of viviparous seeds were obtained (65.33%) with the interaction of late harvesting time and selection-3 (Table 4).

Percentage of axis, rind, edible portion and non- edible portion

The results on the percentage of bulb, seed, axis rind, edible portion and non- edible portion at different times of harvesting have been shown in the Table 2. It was revealed that the percentage of rind was found at late harvesting (48.44%) of jackfruit, which was followed, by mid harvesting (41.31%) and early harvesting times (36.28%). Hossain (1976) determined the percentage composition of ripe fruit from the ten different types of jackfruit. He observed that the rind content of the jackfruit of ten types were in range of 16.48 to 76.89%. When considering the effect of selection on the percentage of rind it was found to be insignificant. The combined effect of harvesting time and selections was found to be significant and From the combination of the harvesting times and selections, percentage of rind ranged from 30.48 to 49.97 per cent, where maximum percentage (49.97) was obtained from the combination of late harvesting time and selection-1 (Table 4). There was significant difference in percent of axis content due to the harvest harvesting times. The axis content of fruit in early harvesting (8.44%) was significantly higher than that of late (6.72%) and mid–harvesting times (Table 2). The percentage of axis of jackfruit also varied significantly among the selections. The selection-3 produced maximum (7.88) percentage of axis content, while Selection-1 the minimum (6.5%) (Table 3). The interaction effect of harvesting times and selections in respect of axis contents were found to be significant, which ranged from 8.91 to 6.20 per cent. The maximum percentage (8.91) was produced by the combination of early harvesting and selection-3 (Table 4).

The results on non-edible portion (rind + axis) showed that there was marked increase of non-edible portion of jackfruit at different harvesting times (Table 2). Among the three harvesting times the percentage of non-edible portion was lowest in early harvesting time (44.72%) and highest in late harvesting time (55.13%). Bhatia *et al.* (1955) reported that the non-edible portion of jackfruit constituted 59.1% of the weight of the fruit. When evaluating the effect of selection on the percentage of non-edible portion it was found to be non-significant (Table 3). The combined effect of harvesting times and selections was found to be significant. Maximum (56.43%) non-edible portion was produced by the combination of late harvesting and selection-2 (Table 4). A significant variation in respect of bulb content of fruit was recorded among the harvesting times. Early harvesting jackfruit gave comparatively greater percentage of bulb than the mid and late harvesting times. Early harvesting time produced highest percentage of bulbs (43.90%) while it was minimum (34.63%) at late harvesting (Table 2). In this result, bulb content jackfruit at three different harvesting times were higher than the findings of Bhatia *et al*. (1955) and Purseglove (1968) who reported 28.7% and 30.00% respectively. There was no significant variation in respect of selection. Again the combined effect of harvesting times and selections were found to be significant and from the combination of harvesting time and selections percentage of bulb ranged from 33.26 to 51.15 per cent, where maximum (51.15%) was obtained from the combination of early harvesting time and selection-1 (Table 4). The different harvesting times exhibited wide variation in respect of seed contents. The maximum content of seed (11.38%) was obtained from the early harvesting while it was minimum (9.60%) at the mid term harvesting. Hossain (1976) found that the average percentage of seed was 10.44% and Bhatia *et al.* (1955) reported 11.5%. The percent results are close to the above findings. The effect of different selections in respect of seed content was found to be insignificant (Table 3). The interaction effects of harvesting times and selection in respect of seed content was statistically significant and varied from 9.43 to 11.93 per cent. Highest seed content (11.93%) was found with the combination of early harvesting time and selection-2 (Table 4). The percentage of the edible portion at different harvesting times varied significantly. Edible portion was higher in early harvesting time (55.28%) and lower in late harvesting (44.87%). Bhatia et al. (1955) reported that the bulb sand seed formed 40.2% of fruit. The effect of different selections in respect of edible portion was found to be insignificant (Table 3). The significant interaction between harvesting time and selection indicated that early harvesting time in association with selection–1 maximum percentage (61.98) of the edible portion (Table 4) while it was minimum (43.56) with late harvesting and selection-2.

Chemical characteristics of jackfruit Bulbs at Different Harvesting Times

Total soluble solids

There was no significant difference in total soluble solid content of bulb due to the harvesting times. The total soluble solids in bulbs of jackfruit at early, mid and late harvesting times were 19.74, 19.68 and 19.60 percent respectively (Table 5). Haque (1993) found that the total soluble solids in green jackfruit were 18% and 20% in ripe jackfruit bulb. Total soluble solid content observed in the present study agree with the above report. There was no significant variation in total soluble solid contents among the selections (Table 6). Interaction between harvesting time and selection was found to be insignificant (Table 7).

p^H of the juice of jackfruit bulb

There was no significant difference in p^H due to the harvesting times (Table 5). Present results showed that the p^H of juice of bulb at different harvesting times were in the range from 5.60 to 5.65. Again, the three selections had effect of insignificant variation in p^H (Table 6). The interaction between harvesting time and selection was found to be significant and it varied from 5.54 to 5.73 (Table 7).

Vitamin C (Ascorbic acid)

Analysis of variance showed that the harvesting time had significant influence on the vitamin C. It was found that the vitamin C content was significantly decreased. The maximum vitamin C content (5.06 mg/ 100g) was obtained from the early harvesting time and the minimum (4.09 mg /100g) late harvesting (Table 5). Hossain and Haque (1979) stated that average ascorbic acid content of the bulb was 5.56 mg/100g. Thus, the present result was found to be close to that of the above authors. There is no significant variation in vitamin C content among the selections. When combined effect of harvesting times and selections were considered, The vitamin C contents were found to be statistically significant and it ranged from 4.93 to 5.07 (Table 7).

Dry matter

Data on changes in dry matter content at different harvesting times derived from percentage moisture content are shown in Table 5. The result showed that the there was gradual increase in dry matter content from early harvesting to late harvesting. There were no significant variations in dry matter content among the selections. The interaction effects of harvesting time and selection were significant. It was found that late periodic harvest associated with selection-1 deposited maximum (22.03%) dry matter and it was minimum (19.10%) with the combination of selection-2 and early harvesting.

Moisture

It was found that the 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 the maximum percentage (80.84) of moisture content while it was minimum (78.34%) at late harvesting. Purseglove (1968) and Sturrock (1959) have reported the moisture content of bulb as 73.1 and 81.08. Thus, the present results were found to be closer to findings of Sturrock (1959). There was no significant difference in percentage of moisture due to selections (Table 6). The interaction effects of harvesting time and selection was found to be significant. The maximum percentage of moisture (80.90) was observed in the combination of early harvesting and selection-2, and the minimum (78.46) from late harvesting and selection-1 (Table 7).

Ash

There was no significant difference in percent ash content of bulb due to harvesting time. The percent ash content showed a general trend of gradual increase with the delaying of harvesting time. At late harvest, jackfruits had highest ash content (1.08%) followed by mid- term harvesting and early harvesting. Similar results were also put forwarded by Watt *et al.* (1963) and Hossain and Haque (1979). There was no significant effect in percent of ash content of bulb due to selections (Table 6). The interaction between harvesting times and selections were statistically found to be significant. Late harvesting time in association with selection-2 exerted maximum ash content (Table 7).

Total Sugar

The analysis of variance showed that the percent total sugar in jackfruit bulb as affected by time of harvesting differed significantly. The maximum percent of total sugar was found in bulb of early harvested fruit (18.18) (Table 5) while it was minimum (13.93) in late ones. Haque (1993) reported wide a range from 15.38 to 26.30. The present results are in the range mentioned by the later. There was no significant difference in percent total sugar content due to selections (Table 6). The interaction effects of harvesting times and selections in respect of total sugar content ranged from 13.64% to 18.35%. Early harvesting time in association with selection-2 gave the highest percent of total sugar content (18.35%) and the lowest (13.64%) was observed with the interaction of selection-3 and late harvesting (Table 7.).

Reducing Sugar

The per cent reducing sugar content was also influenced significantly by harvesting times. It was observed that early harvesting time had maximum (11.01%) percent of reducing sugar of jackfruit bulb while the minimum

(4.89) percent of reducing sugar content was gradually decreased with the delaying of harvesting time. There was no significant difference in percent of reducing sugar due to selections (Table 6). The interaction effect of harvesting time and selection had significant variation. The highest per cent of reducing sugar content was obtained in 11.31% with the combination of early harvesting time and selection-2 and the lowest was observed (4.71%) with the interaction of selection-3 and late harvesting (Table 7).

Non- reducing sugar

The results on non-reducing sugar contents revealed that there was significant variations due to harvesting times of fruit. Non-reducing sugar contents ranged from 7.17% to 9.04%. The highest per cent of non- reducing sugar content was obtained from the late harvesting (9.04%) and the lowest (7.17%) from the early harvested fruit (Table 5). There was no significant difference in per cent non- reducing sugar content due to selections (Table 6). The interaction effects of selections and harvesting times varied significantly. It was clear that early periodic harvest in associated with selection-2 deposited minimum (7.04%) non- reducing sugar content and the maximum was observed (9.10%) with interaction of selection-1 and the harvesting time (Table 7).

Table 1. Effect of harvesting time on the quality of jack fruit bulb

Harvesting time	Texture	Shape	Fibrousness	Juiciness	Flavor	Sweetness
Early	Very soft	Regular in shape	Fibrous	Very juicy	Good	Sweet
Mid- term	Medium soft	Regular in shape	Fibrous	Medium juicy	Average	Medium sweet
Late	Crispy or hard	Mostly irregular	Less fibrous	Less juicy	Not agreeable	Less sweet

Table 2. Effects of harvesting time on the physical characteristics of jackfruit

Characteristics	Early	Mid	Late	LSD value	Level of significant
Weight of fruit (kg)	6.66	7.32	5.744	1.16	**
Weight of bulb (kg)	2.99	3.13	1.99	0.61	**
Weight of seed (kg)	0.76	0.70	0.59	0.13	**
Weight of edible portion (kg)	3.74	3.83	2.58	0.70	**
Weight of axis (kg)	0.55	0.46	0.38	0.09	**
Weight of rind (kg)	2.37	3.02	2.78	0.50	*
Weight of non - edible portion (kg)	2.92	3.48	3.16	0.53	*
% Edible portion	55.28	52.34	44.87	6.66	**
% Axis	8.44	6.36	6.72	1.40	**
% Rind	36.28	41.31	48.44	6.84	**
% Non- edible portion	44.72	47.66	55.13	6.69	**
No. of Bulb	115.00	109.78	95.78	23.42	ns
% viviparous seed	0.00	6.00	59.44	8.90	**

NS = Non- significant, * =Significant at 5% level, ** = Significant at 1% level

Table 3. Effect of selection on the physical characteristics of jackfruit

Characteristics	Selection 1	Selection 2	Selection 3	LSD Value	Level of significant
Weight of fruit (kg)	7.91	6.68	5.14	1.16	**
Weight of bulb (kg)	3.46	2.63	2.02	0.61	**
Weight of seed (kg)	0.79	0.71	0.54	0.13	**
Weight of edible portion (kg)	4.25	3.34	2.56	0.70	**
Weight of axis (kg)	0.52	0.47	0.40	0.09	**
Weight of rind (kg)	3.14	2.86	2.18	0.69	**
Weight of non- edible portion	3.65	3.33	2.58	0.73	**
% Edible portion	53.11	49.78	49.61	4.84	ns
% Axis	6.50	7.14	7.88	1.01	*
% Rind	40.42	43.09	42.51	4.96	ns
% Non-edible portion	46.92	50.22	50.39	6.69	ns
No. of bulb	119.00	106.67	94.89	23.42	*
% Viviparous seed	19.44	22.56	23.44	6.46	ns

NS = Non-significant, * = Significant at 5% level, ** = Significant at 1% level

Table 4. Interaction Effect of harvesting time and selection on the physical characteristics of jackfruit at different harvesting times

Treatments		Weight of fruit (kg)	Weigh t of bulb (kg)	Weight of seed (kg)	Weight of edible portion (kg)	Weight of axis (kg)	Weight of rind (kg)	Weight of non-edible portion	% Bulb	% Seed	% Edible portions	% Axis	% Rind	% Non-edible portion	No. of bulb	% Vivipa rous seed
Early	Selection 1	8.67	4.42	0.94	5.36	0.65	2.66	3.31	51.15	10.83	61.98	7.54	30.48	38.02	138.33	0.00
	Selection 2	6.23	2.46	0.74	3.20	0.55	2.48	3.03	39.51	11.93	51.44	8.87	39.72	48.50	113.33	0.00
	Selection 3	5.08	2.09	0.58	2.67	0.45	1.96	2.41	41.05	11.40	52.45	8.91	38.63	47.55	93.33	0.00
Mid	Selection 1	8.32	3.64	0.78	4.42	0.48	3.42	3.90	43.99	9.43	53.44	5.76	40.82	46.58	118.33	5.67
	Selection 2	7.87	3.45	0.77	4.22	0.46	3.16	3.62	44.43	9.92	54.35	7.86	39.79	45.65	111.33	7.33
	Selection 3	5.77	2.29	0.54	2.83	0.43	3.51	2.93	39.81	9.43	49.24	6.45	43.31	50.75	99.67	5.00
Late	Selection 1	6.73	1.33	0.66	2.99	0.42	3.33	3.74	34.20	9.73	43.93	6.20	49.97	56.17	100.33	52.67
	Selection 2	5.93	1.97	0.61	2.58	0.40	2.95	3.35	33.26	10.31	43.56	6.69	49.75	56.43	95.33	60.33
	Selection 3	4.57	1.68	0.49	2.17	0.32	2.07	2.39	36.45	10.69	47.14	7.27	45.59	52.86	91.67	65.33
LSD Value		2.01	1.06	0.23	1.26	0.15	1.20	1.26	11.03	2.30	11.54	2.42	11.84	11.93	55.90	15.41
Level of significant		**	**	**	**	**	**	**	**	**	**	**	**	**	*	**

NS = Non-significant, * = Significant at 5% level, ** = Significant at 1% level

Table 5. Effects of harvesting time on the chemical characteristics of jackfruit

Harvesting	Total soluble solids (TSS)	P^H	Ascorbic acid	Dry matter (%)	Moisture (%)	Ash (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
Early	19.74	5.60	5.60	19.16	80.84	1.03	11.01	7.14	18.18
Mid	19.68	5.60	5.03	20.86	79.14	1.06	7.32	8.88	16.19
Late	19.60	5.65	4.99	21.73	78.34	1.08	4.89	9.04	13.93
LSD Value	0.14	0.09	0.06	0.49	0.84	0.07	0.65	0.39	0.47
Level of significant	ns	ns	**	**	**	ns	**	*	**

NS = Non-significant, * = Significant at 5% level, ** = Significant at 1% level

Table 6. Effects of selection on the chemical characteristics of jackfruit

Selection	Total soluble solids (TSS)	P^H	Ascorbic acid	Dry matter (%)	Moisture (%)	Ash (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
Selection 1	19.68	5.58	5.05	20.75	79.25	1.04	7.67	8.40	16.09
Selection 2	19.68	5.64	5.02	20.50	79.50	1.09	7.90	8.35	16.25
Selection 3	19.67	5.64	5.01	20.73	79.57	1.04	7.63	9.34	15.97
LSD Value	0.15	0.09	0.04	0.35	0.35	0.07	0.47	0.28	0.34
Level of significant	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS = Non-significant, * = Significant at 5% level, ** = Significant at 1% level

Table 7. Interaction effects of harvesting time and selection on the chemical characteristics of jackfruit at different harvesting times

Harvesting time		Total soluble solids (TSS)	P^H	Ascorbic acid	Dry matter (%)	Moisture (%)	Ash (%)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)
Early	Selection 1	19.70	5.54	5.07	19.29	80.71	0.94	10.92	7.27	18.18
	Selection 2	19.74	5.61	5.07	19.10	80.90	1.06	11.31	7.04	18.35
	Selection 3	19.78	5.65	5.04	19.11	80.89	1.09	10.81	7.21	18.02
Mid	Selection 1	19.76	5.61	4.99	20.94	79.06	1.09	7.17	8.84	16.01
	Selection 2	19.65	5.58	5.07	21.00	79.00	1.08	7.41	8.91	16.33
	Selection 3	19.63	5.62	5.02	20.63	79.37	1.01	7.37	8.87	16.24
Late	Selection 1	19.57	5.58	5.07	22.03	77.97	1.10	4.97	9.10	14.07
	Selection 2	19.64	5.73	4.93	21.40	78.60	1.13	4.99	9.09	14.08
	Selection 3	19.60	5.65	4.97	21.74	78.46	1.02	4.71	8.93	13.64
LSD Value		0.25	0.23	0.11	0.84	0.83	0.12	0.65	0.97	0.81
Level of significant		ns	ns	ns	ns	ns	ns	ns	ns	ns

NS = Non-significant, * = Significant at 5% level, ** = Significant at 1% level

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