J. Hortic. Sci.
Vol. 19(1), 2024

https://doi.org/10.24154/jhs.v19i1.1749

Original Research Paper

Physico-morphological and biochemical characteristics of jackfruit (*Artocarpus heterophyllus* Lam.) genotypes

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ABSTRACT

Thirty-eight jackfruit genotypes including check varieties 'Muttom Varikka' and 'Sindhoor' selected from homesteads of farmers across Kerala, were characterized for their dessert quality. Results revealed that the TSS and total sugar contents of AH-32, AH-18, AH-33 and AH-36 were 32, 25.5, 25.9 and 29.7 °Brix, whereas, the total sugars were 34.75, 25.92, 21.9 and 25%, respectively. Among the accessions, AH-2 recorded the highest total carotenoids (3131.88 µg $100g^{-1}$), which, was higher than check varieties 'Muttom Varikka' and 'Sindhoor'. The genotypes *viz*., AH-18, AH-32, AH-33 and AH-36 can be considered ideal for dessert purpose and can also be used for development of value added products. However, the promising ones can be utilized in breeding programmes to improve quality and yield.

Keywords: Carotenoids, jackfruit, pectin, total phenols, total sugars, TSS

INTRODUCTION

Jackfruit is the 'State fruit' of Kerala and it is believed to have originated in the Western Ghats of India. The fruit ranks first in terms of area (91982 hectares) and production (263000 tonnes) in Kerala with a share of 14.01% (NHB, 2022). Two types of ripe jackfruit, namely, *varikka* and *koozha* are recognized in Kerala based on the texture of bulbs. Trees bearing fruits having firm textured, crunchy flakes are referred to as *varikka* types and those with soft, fibrous and melting flakes are referred to as *koozha*. Flakes of ripe fruits are rich in nutritive value containing carbohydrates (18.9 g), minerals (0.8 g), vitamin A (30 IU) and thiamine (0.25 mg) for every hundred gram (Samaddar, 1985). Suneel et al. (2023) reported that greater variability for thirty characters among 27 jackfruit types across four districts of Karnataka.

The season of jackfruit in Kerala is from March to May. Bumper harvest and resultant market gluts, followed by huge post-harvest losses are recurring problems. Singh & Srivastava (2000) identified eighteen superior clones of jackfruit based on physico-chemical qualities of fruits, bearing, yield and fruit maturity. Jackfruit types with TSS and total sugars more than 25 °Brix and 20% total sugars are found suitable for dessert purpose (Mitra & Maini, 2000). In spite of being a region with high genetic diversity in jackfruit, meagre research has been carried out to identify superior types with dessert quality. Considering the abundance of the fruit in the state and its underutilized status with respect to the scarcity of sufficient number of varieties with specific quality attributes, it is of utmost importance to locate, identify and characterize the available genotypes in terms of dessert purpose. Further, as many of these genotypes have originated as seedlings, there are chances of occurrence of genotypes with superior quality attributes in homesteads across the State. Hence, the present study was conducted to identify jackfruit types with excellent dessert characteristics, so as to utilize these types in future crop improvement programmes.

MATERIALS AND METHODS

Thirty-eight jackfruit genotypes, including two released cultivars (checks), namely, 'Muttom Varikka' and 'Sindhoor' were collected from homestead gardens across several districts of Kerala, over a period of five years (Fig. 1). These fruits were characterized based on their physico-morphological and biochemical traits. The thirty-eight genotypes were considered as treatments and three fruits per genotype were collected for recording the physico-morphological and biochemical characteristics during 2015 to 2019. The weight (g) of each component of the fruit was recorded separately, after cutting the fruit open with a sharp knife with thick wooden handle. The colour of the rind and bulbs was recorded by visual observation. Physico-morphological characters of jackfruit genotypes were recorded as per descriptors suggested by IPGRI (2000). The aroma was detected by a semi-trained panel of fifty judges, aged between 20 and 55. Biochemical parameters like titratable acidity and ascorbic acid were determined as per the procedure of AOAC (1998), while, total carotenoids, pectin, reducing, non-reducing and total sugars were determined as per Ranganna (1997). Total phenols were determined with Folin-Ciocalteau reagent. Phenols react with phosphomolybdic acid in alkaline medium and produce a blue coloured complex (molybdenum blue). The optical density values were recorded at 650 nm on a UV-Visible 1800 spectrophotometer, Shimadzu, Kyoto, Japan (Asami et al., 2003). TSS was estimated with a digital refractometer (Atago, Japan) and the results were expressed in per cent °Brix. The brix: acid ratio was worked out after determining the total soluble solids and titratable acidity.

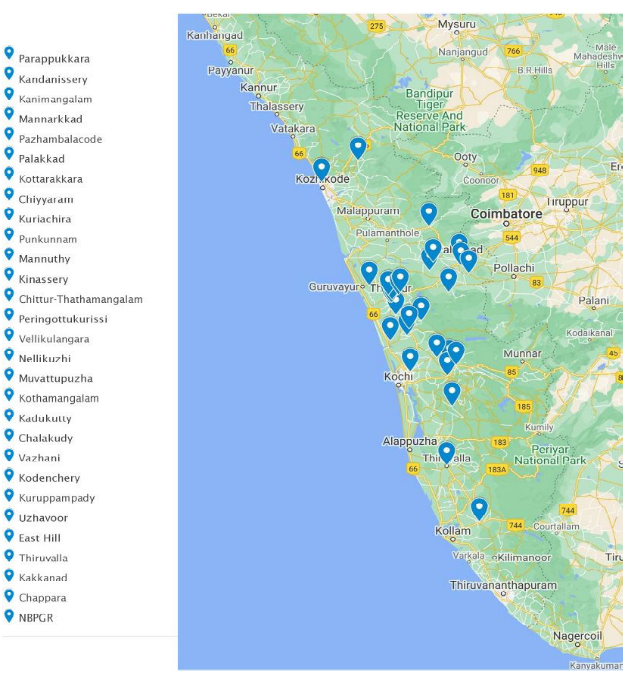

Fig. 1 : Locations of homesteads identified for collection of genotypes in different district of Kerala

RESULTS AND DISCUSSION

Physico-morphological characteristics

Wide variation in physico-morphological attributes was observed among the screened genotypes (Table 1). The flake colour varied from shades of yellow to coppery and light red (Fig. 2). Fruit weight ranged from 3.85 kg (AH-31) to 23.3 kg (AH-25), varied almost 20 fold. Suneel et al. (2023) reported that fruit weight varied from 0.9 kg to 9.30 kg, while, Azad (2000) reported a range of 2.44 to 21.0 kg in jackfruit accessions. Fruit diameter ranged from 18.4 cm (AH-6) to 30.5 (AH-9), however, number of flakes was recorded highest in AH-26 (618) and lowest (48) in AH-7. The difference in the weight of 100 bulbs was about 97% between the genotypes (AH-32 and AH-8). These findings are in accordance with Azad (2000). Percentage of rind also differed significantly from 11.83% (AH-1) to 66.21 (AH-21). Wide variation in edible and non-edible parts was reported by Mathew (1999) in 29 types of jackfruit.

Fruit length varied from 28.0 cm (AH-23) to 67.8 cm (AH-26), however, the fruit girth differed significantly from 27.3 cm (AH-24) to 94.4 cm (AH-9). The fruit weight ranged from 3.85 kg (AH-31) to 23.3 kg (AH-25), which varied almost 20 fold. Suneel et al. (2023) reported that fruit weight varied from 0.9 kg to 9.30 kg, while, Azad (2000) reported a range of 2.44 to 21.0 kg in jackfruit accessions. Fruit diameter ranged from 18.4 cm (AH-6) to 30.5 (AH-9), while, number of flakes was recorded highest in AH-26 (618) and lowest in H-7 (48). The weight of 100 bulbs recorded significant variation with AH-8 (0.11 kg) to 4.03 kg AH-32, which varied about 97%. Pulp percentage, which constitute the edible portion of jackfruit showed significant variation, ranged from to 5.80 (AH-3) to 44.18% (AH-38), whereas, rachis percentage varied from 4.16% (AH-4) to 16.73 (AH-30). Percentage of rind also differed significantly from 11.83% (AH-1) to 66.21 (AH-21). Wide variation in edible and non-edible parts was reported by Mathew (1999) in 29 types of jackfruit. The wide variation in the morphological characters of the screened accessions may be due to the differences in the genotypic constitution which results in variable phenotypic characters. Further, the growing conditions, cultural practices and environment also play very important role in the qualitative and quantitative characters of the accessions. Due to cross pollination and predominance of seed propagation over a long period of time, there is high degree of genetic diversity within the species. This wide range of variation existing in nature aids in the selection of superior desirable types (Jagadeesh et al., 2010).

Table 1 : Physico-morphological characters of jackfruit genotypes

Accession	Fruit length (cm)	Fruit girth (cm)	Rind (%)	Fruit weight (kg)	Fruit diameter (cm)	Bulbs (No.)	100 bulb weight (kg)	100 seed weight (kg)	Flakes (%)	Seed (%)	Rachis (%)
AH-1	30.30	63.30	11.83	6.13	18.90	109.00	1.42	0.30	27.13	14.48	6.00
AH-2	28.80	64.00	26.86	5.39	18.50	125.00	1.00	0.20	33.93	13.68	8.40
AH-3	29.60	51.10	61.83	8.43	20.50	57.00	3.12	1.65	5.80	8.33	7.26
AH-4	28.60	63.00	21.14	5.60	19.40	156.00	1.41	0.60	27.91	16.26	4.16
AH-5	52.60	78.80	41.00	11.87	27.30	218.00	1.22	0.50	23.99	11.23	7.03
AH-6	43.50	53.80	53.50	6.47	18.40	80.00	1.62	0.70	18.75	8.50	8.16
AH-7	39.30	61.70	60.67	5.24	21.40	48.00	0.93	1.01	7.53	8.36	4.33
AH-8	51.60	94.40	51.83	20.13	30.50	185.00	2.02	0.71	20.60	7.56	5.16
AH-9	34.30	76.60	36.47	9.52	24.40	193.00	1.60	0.50	43.04	10.40	10.23
AH-10	43.50	80.00	50.58	12.58	22.60	300.00	0.71	0.30	35.57	16.66	7.96
AH-11	29.80	57.50	48.40	3.95	18.50	71.00	0.22	0.72	13.90	13.43	6.53
AH-12	40.60	74.50	35.63	9.63	20.50	178.00	0.72	0.51	13.34	8.63	6.83
AH-13	40.10	65.60	43.23	6.48	19.30	88.00	0.59	0.51	13.58	7.11	8.34
AH-14	50.80	84.80	28.55	12.23	27.60	395.00	2.41	0.71	38.26	15.55	6.32
AH-15	41.80	67.00	37.10	8.15	26.80	163.00	0.27	0.70	27.20	16.93	5.78
AH-16	41.60	66.60	44.99	6.73	25.10	143.00	1.20	0.31	24.06	10.99	5.36
AH-17	38.00	60.80	48.24	4.89	20.20	50.00	0.32	0.12	32.34	10.56	5.01
AH-18	43.00	58.50	44.06	5.34	18.60	180.00	1.10	0.91	41.61	17.18	9.56
AH-19	37.50	55.30	66.21	5.60	18.90	139.00	1.08	0.21	17.99	12.55	10.71
AH-20	44.00	74.00	36.84	9.50	24.10	198.00	2.02	0.65	42.10	13.68	5.26
AH-21	28.00	28.80	37.74	5.02	19.90	73.00	2.31	0.39	36.19	5.97	6.00
AH-22	31.00	27.30	54.88	6.31	22.00	171.00	1.82	0.81	26.20	12.55	14.18
AH-23	61.80	40.20	29.02	23.30	26.00	520.00	1.68	1.68	37.61	37.61	8.71
AH-24	67.80	81.00	43.92	17.50	28.00	618.00	0.78	0.78	25.33	16.58	11.61
AH-25	53.10	81.50	40.56	18.33	23.20	357.00	1.62	0.96	34.35	19.61	6.92
AH-26	38.60	64.70	33.18	5.850	22.50	151.00	2.85	0.58	29.15	14.41	14.06
AH-27	43.60	85.50	28.74	10.59	28.50	185.00	1.05	1.05	38.48	19.63	4.79
AH-28	55.10	81.10	41.85	13.89	23.90	111.00	3.88	1.51	30.67	8.15	16.73
AH-29	29.70	58.10	41.21	3.85	18.70	75.00	1.10	0.64	33.27	12.64	6.80
AH-30	60.80	80.00	43.84	14.52	30.00	135.00	4.03	0.94	32.52	10.60	6.62
AH-31	43.00	78.00	55.56	11.25	23.00	112.00	2.00	1.00	22.80	8.89	6.22
AH-32	43.00	68.00	34.07	6.75	20.00	125.00	1.20	0.50	18.52	9.63	8.00
AH-33	45.00	72.00	44.03	7.95	20.00	140.00	1.50	1.00	20.13	15.09	7.55
AH-34	39.00	71.00	28.69	6.10	23.00	131.00	2.05	0.60	39.34	9.84	6.56
AH-35	41.00	67.00	40.82	6.12	19.50	139.00	1.30	0.50	26.94	10.61	6.12
AH-36	58.00	71.00	22.07	11.85	21.50	275.00	1.85	0.55	44.18	12.83	8.48
Sindhoor	40.50	79.30	54.28	11.54	25.80	186.00	0.11	0.63	18.50	10.60	11.38
Muttom Varikka	47.00	64.50	43.54	7.83	21.00	131.00	1.10	0.50	23.56	14.01	6.50
CV (%)	2.35	1.49	2.42	10.78	4.43	0.57	3.45	53.83	3.53	7.73	12.85
CD (5%)	1.63	1.63	1.62	1.63	1.63	1.63	0.08	0.61	1.62	1.62	1.62

Fig. 2 : Variability in flake colour of jackfruit genotypes

Table 2: Biochemical characters of jackfruit genotypes

Accession	Acidity (%)	Ascorbic acid (mg 100 g^{-1})	Total carotenoids (μg 100 g^{-1})	Reducing sugars (%)	Non- reducing sugars (%)	Total phenols (mg g^{-1})	Pectin (%)	Brix: acid ratio
AH-1	0.75	8.00	209.56	10.12	4.41	0.54	1.50	34.20
AH-2	0.37	7.69	3131.88	9.48	5.34	0.78	1.23	54.950
AH-3	0.46	6.25	559.26	8.03	6.82	0.49	2.53	55.36
AH-4	0.32	12.50	563.12	9.31	5.86	0.87	1.79	84.68
AH-5	0.48	5.71	2102.06	8.15	7.33	0.44	1.72	62.91
AH-6	0.48	5.55	1929.78	8.71	6.84	1.81	1.03	58.75
AH-7	0.32	5.88	308.56	7.63	10.01	1.95	1.92	87.18
AH-8	0.19	6.89	734.11	8.60	6.25	0.87	2.00	135.29
AH-9	0.32	6.45	1055.53	7.73	7.00	0.74	1.89	75.62
AH-10	0.16	6.25	525.87	11.44	4.82	0.44	1.49	156.25
AH-11	0.53	9.09	842.11	17.29	7.54	0.96	4.52	45.59
AH-12	0.32	8.00	593.97	9.70	6.99	1.38	1.69	72.50
AH-13	1.12	4.00	231.42	9.48	9.22	1.30	1.95	18.93
AH-14	0.42	4.36	233.99	9.50	8.07	0.22	0.79	67.14
AH-15	0.51	8.69	227.56	8.49	7.66	0.22	2.57	39.45
AH-16	0.48	5.88	377.75	9.90	6.67	0.58	1.83	52.71
AH-17	0.16	2.72	829.54	5.68	7.69	0.32	1.10	158.70
AH-18	0.19	4.08	542.54	6.97	18.52	0.32	1.74	134.21
AH-19	0.12	4.44	408.19	5.69	7.44	0.50	1.46	215.00
AH-20	0.16	4.50	929.10	9.13	4.66	0.42	2.02	143.70
AH-21	0.48	4.65	795.18	4.44	12.74	0.31	8.39	54.30
AH-22	0.16	6.97	203.13	6.19	5.59	0.64	0.70	163.70
AH-23	0.32	6.97	550.26	6.86	13.18	0.30	0.99	64.60
AH-24	0.13	4.76	217.92	6.95	5.43	1.95	1.09	183.00
AH-25	0.19	4.76	402.41	7.95	5.89	0.24	1.24	108.42
AH-26	0.21	4.65	251.34	5.31	7.59	0.31	1.48	137.10
AH-27	0.29	5.68	919.89	6.23	6.38	0.30	0.25	91.00
AH-28	0.21	5.00	643.47	7.06	6.56	1.15	2.32	138.50
AH-29	0.12	6.25	500.120	8.20	9.98	0.73	1.53	220.80
AH-30	0.36	4.16	645.40	2.64	7.87	0.42	2.35	63.30
AH-31	0.48	6.06	269.71	10.89	7.60	1.72	1.13	41.70
AH-32	0.32	8.57	1265.10	16.50	18.20	0.96	1.47	100.00
AH-33	0.32	7.14	270.00	5.80	16.10	1.21	1.69	92.81
AH-34	0.38	9.23	802.30	12.17	5.03	1.10	1.49	81.58
AH-35	0.13	6.15	723.19	6.42	4.12	2.03	1.71	185.94
AH-36	0.51	16.00	925.68	9.79	15.21	3.70	0.50	58.82
Sindhoor	0.32	5.88	2707.61	8.15	5.84	0.46	2.15	85.31
Muttom Varikka	0.64	10.00	3121.60	13.35	3.27	1.50	1.50	39.06
CV (%)	17.55	3.48	0.67	2.24	3.61	3.48	2.74	1.04
CD (5%)	0.10	0.37	9.02	0.31	0.47	0.05	0.08	1.63

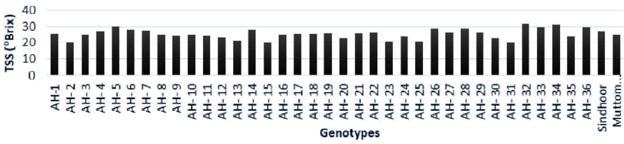

Fig. 3 : Total soluble solids (p Brix) of jackfruit genotypes

Biochemical characteristics

Total soluble solids, which is important for dessert quality of jackfruit, ranged from 20 °Brix (AH-15 and AH-31) to 32 °Brix (AH-34) (Fig. 3). Reddy et al. (2004) and Azad (2000) also reported very high variation in total solids content of jackfruit. Tiratable acidity was recorded lowest (0.12 %) in AH-21 and AH-31, while, it was highest (1.12%) in AH-14. Jagadeesh et al. (2007) also observed wide variation in acidity of jackfruit accessions of coastal Karnataka. The soluble solids along with the acidity in determining the overall acceptability and dessert quality. Though, jackfruit is not a rich source of vitamin C, some genotypes possess fairly good amounts, varied from 2.72 mg (AH-19) to 16.0 mg100g^{-1} (AH-38), which was significantly higher than the check varieties. Similar levels of ascorbic acid (5.8 to 10.0 mg100 g^{-1}) were also reported by Selvaraj & Pal (1989). Carotenoids are antioxidant pigments which determine the colour of the bulbs. It varied significantly among the accessions with AH-2 recording the highest content (3131.88 µg 100g^{-1}), which, was higher than 'Muttom Varikka' (3121.6 µg 100g^{-1}). Jagadeesh et al. (2007) reported total carotenoid content in the range of 0.251 to 0.701 mg100g^{-1} in jackfruit genotypes of coastal Karnataka. Besides TSS, total sugars in jackfruit is also another constituent that determines the dessert quality of ripe jackfruit. Total sugars recorded highest in AH-34 (34.75 %), while, lowest recorded in AH-32 (10.52 %) (Fig. 4). Ghosh (1996) reported a total sugar content (20.6%) in *varikka* types of jackfruit.

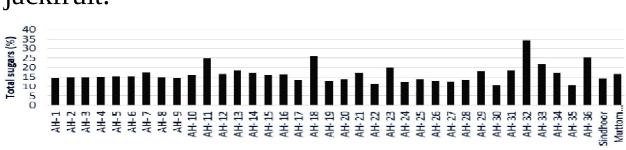

Fig. 4 : Total sugars (%) of jackfruit genotypes

Phenolic compounds are one of the potent antioxidants. Total phenols in jackfruit genotypes ranged from 0.22 mg g^{-1} (AH-14 and AH-15) to 3.70 mg g^{-1} (AH-36). The findings are in consonance with Vilaschandran et al. (1982). Pectin content, which is responsible for firmness in ripe jackfruit, wherein AH-21 had the highest pectin content (8.39 %), while, lowest (0.25 %) was in AH-27. Rahman et al. (1995) also reported that higher pectic polysaccharides were responsible for crunchy texture. Brix: acid ratio also varied significantly highest ratio in AH-29 (220.80), while lowest recorded in AH-13 (18.93). Wide variation in brix: acid ratio may be due to the high variation in acidity and total soluble solids in the screened genotypes. Jagadeesh et al. (2007) also reported high variation in brix: acid ratio of jackfruit accessions of coastal Karnataka. Cluster analysis for biochemical characteristics also revealed significant variations among genotypes (Fig. 5) which could be attributed to the influence of genetic and environmental factors.

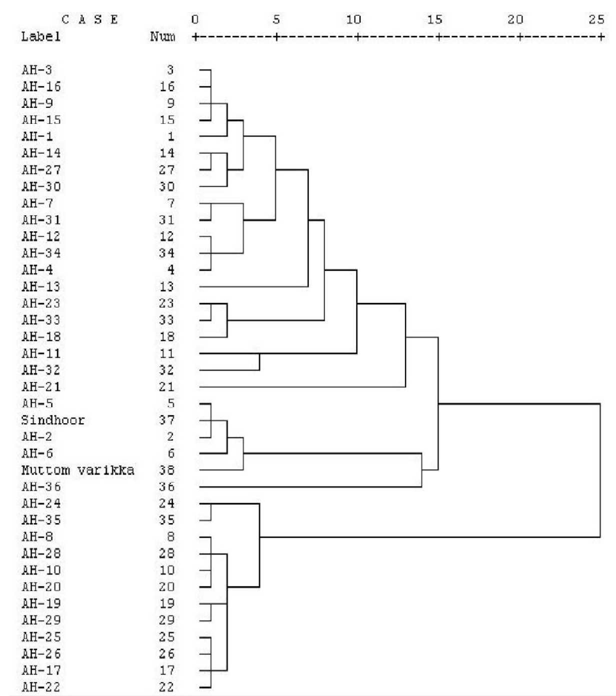

Fig. 5 : Dendrogram based on biochemical characters of jackfruit genotypes

CONCLUSION

The present study identified four promising jackfruit genotypes, *viz*., AH-18, AH-32, AH-33 and AH-36 based on their total soluble solids (>25 °Brix) and total sugar contents (>25%), which are important criteria of dessert jackfruit. All the four genotypes had appreciable levels of pectin, which is responsible for determining dessert quality (firm, crisp texture) of jackfruit genotypes.

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(Received : 11.11.2023; Revised : 17.05.2023; Accepted :21.05.2024)