

Variability in Fruiting Season and Quality Attributes of Jackfruit (*Artocarpus heterophyllus* Lam.) Accessions of Kerala

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ABSTRACT: Kerala, which lies in the southern most part of Western Ghats, is well known for its diversity in jack fruit. The peak season of availability of the fruit in Kerala is during March to May. However, a major chunk of the production is wasted due to lack of post harvest technological interventions. The present study aims at collection and evaluation of jack fruit accessions to obtain information on fruiting season and also to identify accessions with superior dessert qualities. Jack fruit accessions with off season fruiting, beginning from January and extending up to July were identified in the present study. Accession AH-6 produced fruits round the year. Wide variation was observed in physico-morphological characteristics like fruit shape, weight, rind colour and percentage composition of the various constituents. Accession AH-8 recorded the maximum fruit weight (20.13kg) while percentage of pulp was highest (43.04%) in AH-9. Accession AH-10 had the highest number of bulbs (300). Significant variation in the biochemical constituents was also observed. Total soluble solids, titrable acidity, total sugars, brix: acid ratio exhibited maximum variation among the biochemical attributes. Highest total soluble solids were recorded in AH-5 (30.2° Brix) whereas total carotenoids were highest in AH-2 which was on par with the check cultivar Muttam Varikka.

Key words: Accession, biochemical, physico-morphological, jackfruit

INTRODUCTION

Jackfruit originated in the Western Ghats of India and is extensively grown in this region for its ripe and unripe fruits. Ripe jackfruit, owing to its strong aroma and intense sweetness, is widely relished for dessert purpose, whereas unripe fruits are mostly utilised in culinary preparations and also in pickle making. 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 bulbs are referred to as *koozha*. *Varikka* types are preferred to *koozha* for dessert purpose and hence the ripe bulbs of *koozha* types are usually wasted. Flakes of ripe jackfruit are good sources of carbohydrates, minerals, vitamins A and B.

Among the fruit crops grown in Kerala, jackfruit has a prominent position as the area under jackfruit is next only to banana, which comes to 89702 hectares as reported in Farm Guide [3]. Season of availability of ripe jackfruit in Kerala is from March to May. Post harvest losses and market gluts are usual problems encountered during the season. Jackfruit is considered

as an underutilised fruit in Kerala considering its large scale production, meagre utilization in processing sector and huge post harvest losses. However, owing to its popularity within the country and also in those countries where sizable ethnic Indians live, there exist ample opportunities to identify promising types with superior quality and off-season availability to ensure remunerative returns to the growers.

Being a highly cross pollinated crop, innumerable types of jackfruit accessions are found in areas where it is grown. Variations in tree forms, season of fruiting, size, shape and colour of fruit, flavour, colour and texture of bulbs, nutritional and biochemical constituents offer ample scope to identify promising types with off-season bearing habit and also possessing excellent table purpose qualities. Singh [15] characterised jackfruit types depending on size of fruit, taste, odour of flesh, nature, shape and diversity of prickles on the rind. Singh and Srivastava [16] identified eighteen superior clones of jackfruit based on physico-chemical qualities of fruits, bearing, yield and fruit maturity. Jackfruit types with TSS and total sugar more than 25° Brix and 20 per cent,

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respectively were found suitable for dessert purpose by Mitra and Maini [10]. TSS recorded more variability and it ranged from 24.8 to 40.5°Brix in the clones identified by Reddy *et al.* [13]

Predominance of seedling trees has resulted in wide variation in the genetic diversity within the same species. Moreover, identification of off season types with superior flavour attributes will help in the multiplication and subsequent cultivation of these elite types on a commercial scale. In spite of being a region with high genetic diversity in jackfruit, little research has been done in Kerala to identify superior types with off-season bearing habit and also possessing excellent flavour attributes. Hence, the present study was taken up with the financial assistance of the Indian Council of Agricultural Research, to select jackfruit types with extended period of availability of fruit and also possessing excellent dessert characteristics, so as to utilise these types in future crop improvement programmes. Moreover, these jackfruit types will also enable the small scale entrepreneurs in the State significantly in their efforts in value addition.

MATERIALS AND METHODS

Eighteen accessions of jackfruit, including two popular (check) cultivars viz. Muttam Varikka and Sindhur (red fleshed), collected from homestead gardens across Kerala, over a period of two years were evaluated to study the variability in fruiting season and physico-morphological and biochemical attributes. Fruits of each accession were harvested at mature, unripe stage by cutting the peduncle with a sharp knife. Fruits borne on the higher branches were collected by lowering them with a rope after cutting with a knife. The harvested fruits were then transported to the laboratory of the Department of Processing Technology, College of Horticulture. Firm, ripe bulbs of these fruits were used to assess the variability in physico-chemical attributes and also to determine their organoleptic acceptability. The eighteen accessions were considered as treatments and three fruits per accession were collected for recording the physico-morphological and biochemical characteristics. Locations from where the fruits were collected and their accession numbers (codes) are given in Table 1.

Total weight of the fruit was recorded in kilograms. Weight of each component of the fruit was recorded separately, after cutting the fruit open. Colour of the rind and bulbs was recorded by visual observation. Physico-morphological characters of

Table 1
List of jackfruit accessions identified and places of their occurrence

Location	Accessions with code
Parappukara	AH-1
Kandanisseri	AH-2
Kanimangalam	AH-3,AH-4
Mannarkkad	AH-5
Pazhambalacode	AH-6
Chandranagar	AH-7
Chiyyaram	AH-8
Kuriachira	AH-9,AH-11,AH-12
Mundathicode	AH-10
Poonkunnam	AH-13,AH-14,AH-15
Mannuthy	AH-16
Kottarakkara	Sindhur
Thrissur	Muttam Varikka

jackfruit accessions were recorded as per descriptors suggested by IPGRI [7]. Percentage of pulp was calculated by recording the weight of all the bulbs in a fruit, after removing the seeds from the bulbs. Biochemical parameters like titratable acidity, ascorbic acid, carotenoids and phenols were determined as per the procedure laid down by AOAC [1] while pectin, reducing sugars, non-reducing sugars and total sugars were determined as per the procedure suggested by Ranganna [12]. Total soluble solids were determined with a hand refractometer and brix: acid ratio was worked out after determining the total soluble solids and titratable acidity.

RESULTS AND DISCUSSION

Variation in physico- morphological and biochemical attributes was found significant in the accessions included in the investigation. Availability of fruits from the accessions identified extended from January to July. Physico-morphological characteristics and fruiting seasons showed considerable variation in the accessions investigated (Tables 2 a. & 2 b.).

Significant variation in fruit characteristics was also reported by Haq [5]. Normal season of harvest of jackfruit in Kerala is from March to May. However, in the present investigation, accession AH-6 was found to bear fruits through out the year. Three accessions, namely AH-1, AH-2 and AH-5 come to maturity as early as January end, whereas accession AH-16 matures in July; thereby indicating the possibility of finding accessions with off-season fruiting. Significant differences in fruit length, girth and diameter were observed in the accessions. Considerable variation was also noticed in rind and bulb colour. Bulb colour is an important attribute that

contributes to organoleptic quality. In the present study, bulb colour ranged from creamish yellow in AH-1 to different hues of yellow in the other accessions. Colour of the bulbs in the check cultivar Sindhur is reddish. Fruit weight of the accessions varied significantly ranging from 3.95 kg in AH-11 to 20.13kg in AH-8. Similar range (2.44-21.0 kg) in weight of jackfruit accessions was reported by Azad [2]. Fruit weight and number of bulbs were not interdependent. Number of bulbs ranged from 48 in the accession AH-7 to 300 in AH-10. Proportion of pulp in the accessions varied from 5.80 in AH-3 to 43.04% in AH-9. The findings are in conformity with those reported by Haq [6]. Percentage of seeds varied from 7.11% in AH-13 to 16.393 in AH-15. Percentage of rachis varied from 4.16 in AH-13 to 11.38 in check cultivar Sindhur. Rind constituted to 11.83% in AH-1 to 61.83% in AH-3. Weight of 100 seeds ranged from 0.20 in AH-2 to 1.64kg in AH-3. Similarly, weight of 100 bulbs ranged from 0.113 in check cultivar Sindhur to 3.12kg in AH-3. These findings are in accordance with those reported by Azad [2]. Wide variation in edible and non-edible parts was reported by Mathew [9] in 29 types of jackfruit.

A significant variation in biochemical constituents was observed in all the jackfruit accessions (Table 3.)

Titrateable acidity was highest (1.12 %) in AH-13 whereas AH-10 recorded the lowest acidity (0.16%). Jagadeesh *et al.* [8] observed wide variation in acidity of jack fruit accessions of coastal Karnataka. Similarly, total soluble solids (TSS) also showed considerable variation. Accession AH-5 had the highest total soluble solids (30.2° Brix) and the lowest was observed in AH-16 (20.0° Brix) which was on par with the total soluble solid content of AH-2 (20.5° Brix). Reddy *et al.* [13] and Azad [2] also reported very high variation in total soluble solid content of ripe jack fruit. The brix: acid ratio of all the accessions exhibited wide variation and the accession AH-10 had the highest brix: acid ratio of 151.25 while the lowest was in AH-13 (20.71). High variation in brix: acid ratio is mainly due to the wide variation in acidity and TSS which is evident in all the accessions included in the present study. Jagadeesh *et al.* [8] also reported that TSS: acid ratio of the jack fruit accessions of coastal Karnataka was one of the biochemical constituents that exhibited highest variation. The reducing sugars, mainly responsible for sweetness, were highest in the accession AH-11, while the lowest was observed in AH-7. Similarly, total sugars were also highest in AH-11, which was significantly higher (24.82%) as compared to other accessions. Ghosh [4] reported a

Table 2a
Physico- morphological characteristics of jack fruit accessions

Accessions	Length (cm)	Girth (cm)	Fruit weight (kg)	Fruit diameter (cm)	No. of bulbs	Pulp (%)	Seed (%)	Rachis (%)	Rind (%)	100 bulb weight (kg)	100 seed weight (kg)
AH-1	30.33	63.33	6.137	18.93	109.0	27.13	14.48	6.00	11.83	1.425	0.300
AH-2	28.83	64.00	5.395	18.50	125.0	33.93	13.68	8.40	26.86	0.998	0.202
AH-3	29.60	51.13	8.428	20.50	57.0	5.80	8.33	7.26	61.83	3.125	1.646
AH-4	28.66	63.00	5.600	19.43	156.0	27.91	16.26	4.16	21.14	1.412	0.605
AH-5	52.66	78.83	11.874	27.33	218.0	23.99	11.23	7.03	41.00	1.217	0.500
AH-6	43.50	53.83	6.467	18.46	80.0	18.75	8.50	8.16	53.50	1.623	0.703
AH-7	39.33	61.76	5.237	21.43	48.0	7.53	8.36	4.33	60.67	0.932	1.013
AH-8	51.16	94.40	20.133	30.50	185.0	20.60	7.56	5.16	51.83	2.023	0.706
AH-9	34.33	76.66	9.523	24.40	193.0	43.04	10.40	10.23	36.47	1.596	0.503
AH-10	43.50	80.00	12.585	22.60	300.0	35.57	16.66	7.96	50.58	0.713	0.303
AH-11	29.83	57.56	3.952	18.50	71.0	13.90	13.43	6.53	48.40	0.217	0.718
AH-12	40.66	74.50	9.631	20.50	178.0	13.34	8.63	6.83	35.63	0.716	0.513
AH-13	40.16	65.66	6.482	19.36	88.0	42.03	7.11	8.34	43.23	0.591	0.509
AH-14	50.83	84.83	12.233	27.66	395.0	38.26	15.55	6.32	28.55	2.408	0.712
AH-15	41.83	67.00	8.153	26.83	163.0	27.20	16.93	5.78	37.10	0.268	0.705
AH-16	41.66	66.66	6.733	25.10	143.0	24.06	10.99	5.36	44.99	1.203	0.312
Sindhur	40.50	79.33	11.543	25.80	186.0	18.50	10.60	11.38	54.28	0.113	0.627
Muttam varikka	47.00	64.50	7.833	21.00	131.0	23.56	14.01	6.50	43.54	1.100	0.503
CD at 5%	1.897	2.051	0.506	0.985	0.485	1.019	0.804	1.056	1.758	0.029	0.02
SEM	1.872	2.66	0.91	0.896	0.781	2.58	0.791	0.444	3.182	0.183	0.076

Table 2b
Physico-morphological characteristics of jackfruit accessions

Accessions	Fruit thickness	Fruit colour	Fruit shape	Flesh aroma	Flesh colour	Fresh texture	Quantity of fibre	Juiciness of pulp	Seed shape	Season of fruiting	Bearing habit
AH-1	Medium	Green	Ellipsoid	Mild	Creamish yellow	Crisp	Scarce	Medium juicy	Ellipsoid	January -March	Regular
AH-2	Medium	Green	Oblong	Strong	Deep yellow	Crisp	Scarce	Medium juicy	Oblong	January -March	Regular
AH-3	Medium	Light yellow	Long oblong	Mild	Light yellow	Coarse	Scarce	Juicy	Ellipsoid	February-April	Regular
AH-4	Medium	Light green	High spheroid	Mild	Light yellow	Crisp	Scarce	Medium juicy	Oblong	February-April	Regular
AH-5	Medium	Light green	High spheroid	Mild	Yellow	Crisp	Scarce	Medium juicy	Ellipsoid	January-April	Regular
AH-6	Medium	Yellowish green	Ellipsoid	Mild	Yellow	Coarse	Medium	Medium juicy	Ellipsoid	Year round	Regular
AH-7	Medium	Yellowish green	Oblong	Mild	Creamish yellow	Coarse	Medium	Medium juicy	Spheroid	February-April	Regular
AH-8	Medium	Light green	Ellipsoid	Mild	Light yellow	Coarse	Scarce	Less juicy	Oblong	March-May	Regular
AH-9	Medium	Dark green	High spheroid	Mild	Yellow	Coarse	Scarce	Juicy	Oblong	March-May	Regular
AH-10	Medium	Green	Ellipsoid	Mild	Creamish yellow	Coarse	Scarce	Medium juicy	Spheroid	March-May	Regular
AH-11	Medium	Green	High spheroid	Mild	Yellow	Coarse	Scarce	Less juicy	Oblong	April-May	Regular
AH-12	Medium	Green	Ellipsoid	Mild	Yellow	Coarse	Scarce	Less juicy	Oblong	May-June	Regular
AH-13	Medium	Green	Ellipsoid	Mild	Creamish yellow	Coarse	Scarce	Less juicy	Oblong	May-June	Regular
AH-14	Medium	Light green	High spheroid	Mild	Light yellow	Firm	Scarce	Less juicy	Oblong	May-June	Regular
AH-15	Medium	Light green	Ellipsoid	Medium	Creamish yellow	Melting	Scarce	Juicy	Oblong	May-June	Regular
AH-16	Medium	Yellow	Obovate	Strong	Yellow	Crisp	Scarce	Medium juicy	Oblong	June-July	Regular
Sindhur	Medium	Green	Oblong	Mild	Reddish	Melting	Medium	Medium juicy	Ellipsoid	February-April	Regular
Muttam Varikka	Medium	Yellowish green	Ellipsoid	Strong	Yellow	Firm	Medium	Medium juicy	Oval	May-June	Regular

Table 3
Biochemical characteristics of jack fruit accessions

Accessions	Acidity (%)	Ascorbic Acid (mg/100g)	Total phenols (mg/100g)	Pectin (%)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)	Total carotenoids (µg/100g)	TSS (°Brix)	Brix/acidratio
AH-1	0.747	8.00	0.542	1.503	10.117	4.413	14.53	209.557	25.6	34.2
AH-2	0.373	7.69	0.785	1.233	9.477	5.34	14.817	3131.883	20.5	54.95
AH-3	0.457	6.25	0.492	2.527	8.027	6.823	14.85	559.26	25.3	55.36
AH-4	0.320	12.50	0.867	1.787	9.31	5.857	15.167	563.117	27.1	84.68
AH-5	0.480	5.71	0.442	1.723	8.153	7.327	15.48	2102.06	30.2	62.91
AH-6	0.480	5.55	1.810	1.030	8.71	6.84	15.55	1929.783	28.2	58.75
AH-7	0.320	5.88	1.950	1.917	7.633	10.01	17.643	308.56	27.9	87.18
AH-8	0.187	6.89	0.870	2.003	8.603	6.253	14.857	734.113	27.3	145.98
AH-9	0.320	6.45	0.742	1.887	7.73	7.0	14.73	1055.53	25.3	79.06
AH-10	0.160	6.25	0.442	1.487	11.443	4.817	16.26	525.833	24.2	151.25
AH-11	0.533	9.09	0.963	4.523	17.287	7.537	24.823	842.107	25.0	46.9
AH-12	0.320	8.00	1.383	1.687	9.7	6.987	16.687	593.973	24.3	75.93
AH-13	1.120	4.00	1.300	1.950	9.437	9.223	18.66	231.42	23.2	20.71
AH-14	0.420	4.36	0.217	0.790	9.503	8.067	17.237	233.99	21.267	50.63
AH-15	0.507	8.69	0.220	2.567	8.487	7.663	16.15	227.56	28.267	55.75
AH-16	0.480	5.88	0.583	1.827	9.903	6.667	16.57	377.98	20.0	41.66
Sindhur	0.320	5.88	0.460	2.147	8.153	5.84	13.993	2707.61	25.0	78.12
Muttam Varikka	0.640	10.00	1.500	1.503	13.35	3.27	16.62	3121.597	25.333	39.58
CD at 5%	0.141	0.00	0.031	0.076	0.418	0.354	0.168	0.124	0.508	0.463
SEM	0.05	0.49	0.12	0.18	0.55	0.38	0.57	3.4	0.65	0.235

total sugar content of 20.6% in *varikka* types of jackfruit. Wide variation in non reducing sugars was also observed among the accessions. Non reducing sugars were highest in the accession AH-7 (10%) while check cultivar Muttam Varikka recorded the lowest non reducing sugars (3.27%).

Even though jack fruit is not a rich source of ascorbic acid, its content ranged from 4.0-12.5mg/100g in the present study. Accession AH-4 had the highest ascorbic acid content. Similar levels of ascorbic acid (5.8 to 10.0 mg/100g) in ripe jack fruit bulbs were reported by Selvaraj and Pal [14]. Total phenol content in the bulbs of all jackfruit accessions showed wide variation. It varied from 0.21 to 1.95mg/100g. A low level of phenols in ripe jackfruit bulbs is in agreement with the findings of Vilaschandran et.al [17]. Total phenols were highest in the check cultivar Muttam Varikka while the lowest was found in AH-14. Pectin content, which is a key factor responsible for firmness in ripe bulbs, varied significantly in all the accessions investigated. Highest pectin content was found in the accession AH-11 (4.52%) while the lowest was observed in AH-14 (0.79%). Vilaschandran et.al [17] reported a calcium pectate content of 3.2 to 5.8 % in ripe bulbs of jackfruit. Rahman et. al. [11] also reported that higher pectic polysaccharides were responsible for crunchy texture in firm fleshed jack fruit as compared to the soft fleshed form.

Total carotenoids varied significantly in all the accessions. Colour of ripe bulbs is a major factor determining organoleptic quality. Total carotenoid content varied from 209.5 to 3131.5 µg/100g. Highest total carotenoid content was found in the accession AH-2 while the lowest was observed in AH-1. Total carotenoids in AH-2 were higher than that in the check cultivar Muttam Varikka. Jagadeesh et. al. [8] reported total carotenoid content in the range of 0.251-0.701 mg/100g in jack fruit accessions of coastal zone of Karnataka. The present findings indicate that colour of the bulbs is directly correlated to the total carotenoid content. Colour of ripe bulbs of accession AH-2 was deep yellow, which also had the highest total carotenoids while colour in accession AH-1 was creamish yellow, which had the lowest total carotenoids.

Investigation on variability in fruiting season, physico-morphological and biochemical attributes of jackfruit accessions of Kerala revealed considerable variation with respect to these aspects. Accession AH-6 produced fruits round the year and accessions AH-1, AH-2, AH-16 bore fruits with extended availability. Fruit weight, number of bulbs and percentage of pulp

varied significantly in the accessions studied. Similarly, wide variation was also observed in biochemical attributes like total soluble solids, titratable acidity, total carotenoids and brix: acid ratio. Accessions AH-5, owing to its high TSS and AH-11, due to its high reducing and total sugars can be selected for dessert purpose. These accessions can also be utilized in the preparation of value added dehydrated products and also to make jackfruit beverages.

The authors acknowledge with gratitude the financial assistance received from the Indian Council of Agricultural Research to carry out the study.

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