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Inter tree variability in chips purpose jackfruit selections of Western Ghats of Karnataka, India

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Abstract

The 62 jackfruit selections studied for chips purpose from the hilly (34 types) and coastal (28 types) zones of Karnataka in India were grouped into 6 clusters using Toucher's values method employed on the Mahalanobis's generalized distance (D^2) values. Cluster A accounted for 45 selections followed by cluster B (10 selections) and cluster C (4 selections), whereas cluster D, E and F were solitary having single selection each. Inter cluster distance was maximum between cluster E and F (35.842) followed by cluster A and E (28.281) and was minimum between cluster C and D (9.362). The present study reveals that high chips yielding types have also recorded high dry matter content indicating a direct relationship between these characters. The relative contribution of characters clearly indicated that chips recovery contributed maximum for divergence (62.61%) followed by TSS (15.34%) and hence the selection of jackfruits for chips purpose should deem these characters.

Key words: *Artocarpus*, jackfruit, chips, western ghats, diversity, D^2 analysis, cluster distance

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam., Family: *Moraceae*) native to India is not popular as a commercial crop due to wide variation in fruit quality, the long gestation period of plants raised from seeds and the widespread belief that excessive consumption of bulbs leads to certain digestive ailments [1]. Jackfruit is not easy to eat out of hand owing to morphological and/or biochemical hindrances associated with the fruit. Many opine that the jackfruit in the fresh form is not liked by many due to its intense flavour [2, 3]. However, jackfruit is gaining popularity even in the United States due to emerging ethnic and mainstream marketing opportunities [3-5]. Therefore, it is urged that indigenous or under utilized fruits which are not easily marketed in the fresh form should be processed into acceptable products [6]. Product diversification in jackfruit helps in popularising the fruit among the masses as it removes difficulty in separating the bulbs from rind.

Converting jackfruit bulbs into chips add variety to 'salty snacks', a popular group of food item. Interestingly, fruits of some jackfruit trees suitable for dessert purpose may not be appropriate for making chips due to variation in their biochemical composition. A large variation in the chemical composition has been reported even within the dessert type jackfruit selections of Western Ghats of India [7]. In North Canara (Uttara Kannada) and South Canara (Dakshina Kannada) districts of Karnataka (situated in Western Ghats), people have locally identified fruits of certain jackfruit types as suitable for chips. However, no standard jackfruit type suitable for making chips exists so far. Jackfruit being highly cross pollinated and mostly seed propagated in the natural habitat has innumerable variations in sweetness, acidity, flavour and taste in jackfruit growing areas [1, 8]. This wide range of variation existing in nature aids in the selection of superior desirable types for chips purpose.

Crop improvement programme in jackfruit for chips purpose has been initiated at the University of Agricultural Sciences, Dharwad in Karnataka state under National Agricultural Technology Project (CGP-III) with the aim of producing improved chips type jackfruit cultivars for commercial production. In the present investigation, our goal was to classify 62 chips type jackfruit selections studied through an extensive survey of Western Ghats part of Karnataka in India using Mahalanobis D^2 analysis. In order to attempt crop improvement in this crop, there is a need for greater

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understanding of divergence that is present among the jackfruit collections.

Material and methods

A. Plant material

In the present study, 62 jackfruit types selected from natural population in the *Hilly* (34 types) and *Coastal* (28 types) zones of Karnataka situated in Western Ghats of India were covered (Table 1, Fig.1). The fruits for chips purpose were harvested at three fourth to fully mature (but unripe) stage. The trees were marked to facilitate frequent visits if fruits of desired stage were not available during the initial trip. The minimum sample size from each selected tree was three and each fruit was considered as a replication. The fruits were analysed in the laboratory for physico-chemical characters of bulbs at the stage suitable for chips. The chips recovery was worked out after making chips from each of the selection. The protocol followed for chips making in this study was standardized following the method existing in North Canara district of Karnataka [9].

B. Physical parmaeters

a. Bulb length, breadth and thickness

Five bulbs from each fruit were selected at random to measure length and breadth (at the mid point) of each bulb in centimeters. Similarly, five bulbs from each fruit were cut across to facilitate measurement of flake thickness. Flake thickness for each bulb was recorded in centimeter with the help of digital vernier calipers.

b. Dry matter percentage

A known quantity of fresh material was dried in an oven at temperature ranging from 60 to 70°C for 48 hours or till two consecutive weights were constant and the dry matter content was expressed in percentage [10].

c. Chips recovery

Chips recovery for each selection was worked out by taking weight of jackfruit flakes used for chips making and the weight of fried chips obtained. The chips recovery was expressed in percentage.

C. Biochemical parameters

The pulp was analysed for Total Soluble Solids (TSS) by using ERMA hand refractometer, total and reducing sugars content by Dinitrosalicylic acid (DNSA) method [11] and the amount of starch by following the standard method [10].

D. Mahalanobis D^2 analysis

The clustering of selections into different clusters was

Table 1. List of chips purpose jackfruit selections studied from hilly and coastal zones of Karnataka

A. Hilly zone

District/taluka	Selections with code	Total
Uttara Kannada	74°9' – 75°10' Longitude (E), 13°55'-15°31' Latitude (N)	
Sirsi	SRS-1, SRS-2, SRS-3, SRS-4, SRS-5, SRS-6, SRS-7, SRS-8, SRS-12, SRS-13, SRS-14, SRS-15, SRS-16, SRS-17, SRS-18, SRS-19, SRS-25, SRS-26, SRS-27, SRS-28, SRS-29, SRS-30, SRS-31	23
Yellapur	UKY-2, UKY-3, UKY-5, UKY-6, UKY-8, UKY-10, UKY-11,UKY-12,UKY-13, UKY-14, UKY-31	11
Total		34

B. Coastal zone

District/taluka	Selections with code	Total
Uttara Kannada	74°9' – 75°10' Longitude (E), 13°55'-15°31' Latitude (N)	
Honnavara	UKH-16, UKH-17, UKH-20, UKH-21, UKH-23	5
Udupi		
Udupi	UDB-14, UDB-15, UDB-16, UDP-18, UDB-19, UDB-20, UDB-21, UDB-22, UDB-23, UDB-24, UDB-25, UDB-26	12
Dakshina Kannada*	74°35'–75°40' Longitude (E), 12°27'-13°58' Latitude (N)	
Mangalore	DKM-23	1
Bantwala	DKB-5, DKB-8, DKB-11, DKB-13, DKB-15, DKB-16, DKB-18,DKB-20,DKB-21, DKB-22	10
Total		28

*****It represents latitude and longitude of erstwhile Dakshina Kannada district which includes the newly carved out district of Udupi

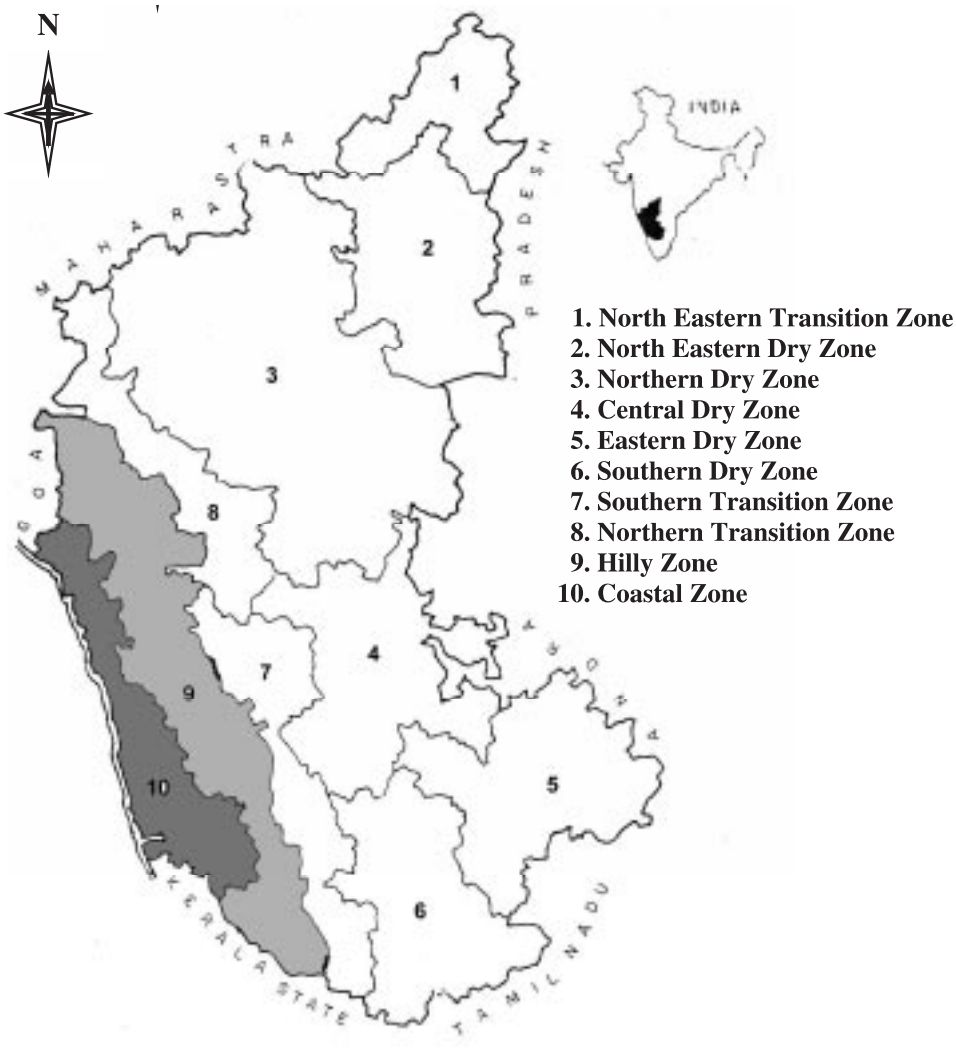

Fig. 1. Agro-climatic zones of Karnataka (India) indicating zones surveyed for chips purpose jackfruits

done by Toucher's method [12]. The intra and inter cluster distance as well as cluster means were calculated [13].

Results and discussion

The analysis of variance for 9 quantitative characters showed significant differences among 62 selections indicating the existence of diversity.

Clustering of selections

Among the 6 clusters formed, Cluster B accounted for 10 selections (SRS-1, SRS-2, SRS-3, SRS-7, SRS-15, SRS-26, SRS-27, DKB-13, UKY-5 & DKM-23) and cluster C for 4 selections (SRS-13, UKY-11, UKY-14 & UKY-31), whereas cluster D, E and F were solitary with selections UKH-17, SRS-29 and UDP-18 respectively. Rest of the 45 selections belonged to cluster A (Fig. 2).

It is apparent that selections coming from different ecogeographic areas were grouped into the same cluster and selections belonging to same geographic origin were included in different clusters. Previous reports [14, 15] also evidenced jackfruit selections coming from different ecogeographic areas occupying the same cluster, while the selections originating in the same geographic areas occupying different clusters suggesting that geographic diversity does not necessarily represent genetic diversity. Improvement in yield and quality of highly cross pollinated crops like jackfruit is generally achieved by selecting the types with desirable character combinations existing in nature [14, 15]. The clustering pattern in the present study indicates wide diversity existing in jackfruit population in nature.

Average intra and inter cluster distances

The maximum intra cluster distance was observed in cluster C (6.823) followed by cluster A (6.774) and cluster

Table 2. Cluster means for 9 character in 62 chips type jackfruit selections of hilly and coastal zone of Karnataka

Sl. No.	Character	Cluster					
		A	B	C	D	E	F
1.	Bulb length (cm)	5.97	5.14	4.54	5.87	5.13	4.83
2.	Bulb breadth (cm)	3.55	3.15	3.67	2.63	3.00	4.60
3.	Flake thickness (cm)	0.39	0.36	0.33	0.35	0.28	0.36
4.	TSS (°B)	6.68	8.31	13.64	14.93	6.13	7.00
5.	Total sugars (%)	2.63	4.02	8.57	10.01	1.21	6.10
6.	Reducing sugars (%)	1.16	1.82	3.13	3.19	0.49	2.96
7.	Starch (%)	16.88	19.97	11.57	14.16	13.76	24.37
8.	Dry matter (%)	21.43	26.06	22.34	25.88	17.08	31.51
9.	Chips recovery (%)	42.69	52.22	45.72	52.38	32.00	62.50

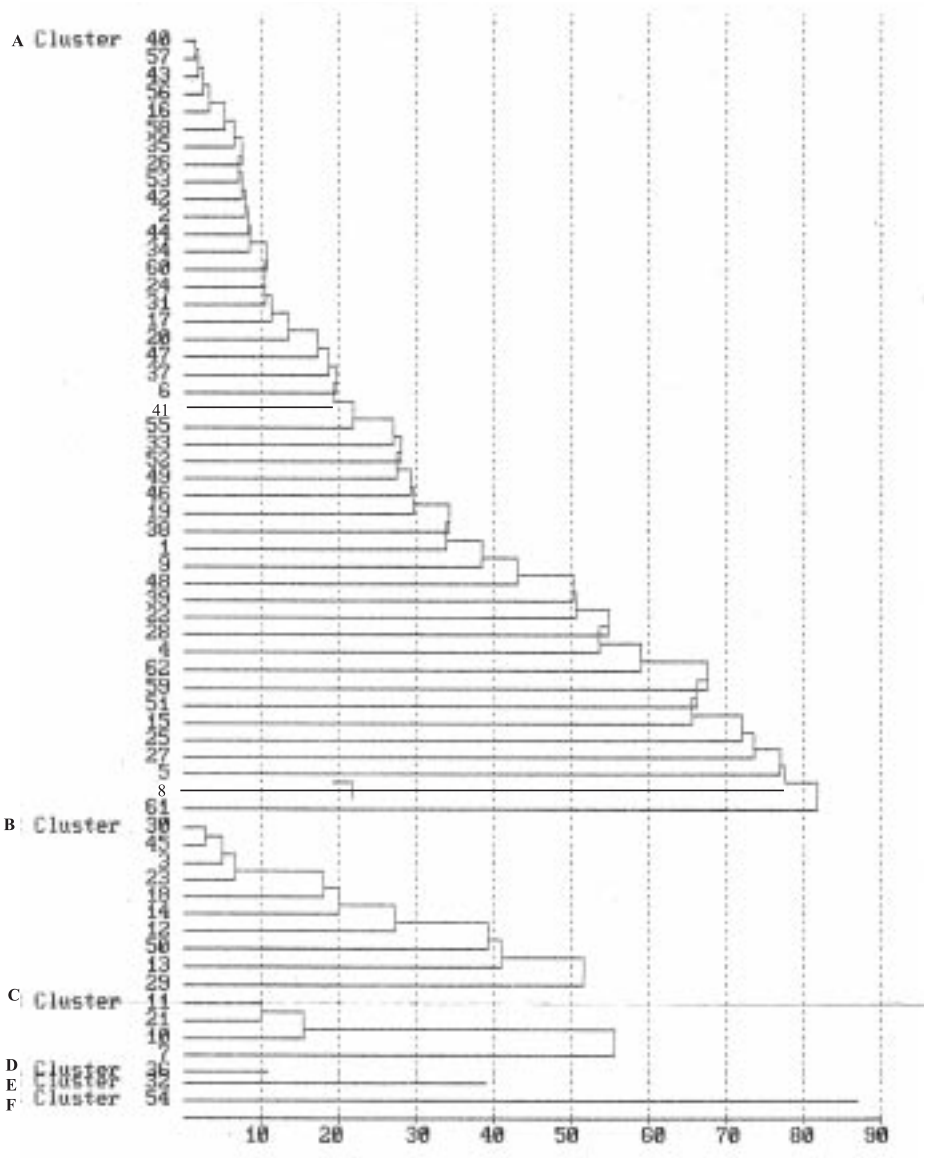

Fig. 2. Clustering pattern in 62 chips type jackfruit selections

B (6.042) (Fig. 3). This offers scope for selection of best types with maximum intra cluster distance within the cluster. Inter cluster distance was minimum between cluster C and D (9.362) followed by cluster B and D (11.514) indicating that the selections of these clusters were close to each other in the performance of the important qualitative and quantitative parameters considered. The maximum inter cluster distance was noticed between cluster E and F (35.842) followed by cluster A and E (28.281). Those selections included in clusters with maximum inter cluster distance are obviously more divergent [14, 15].

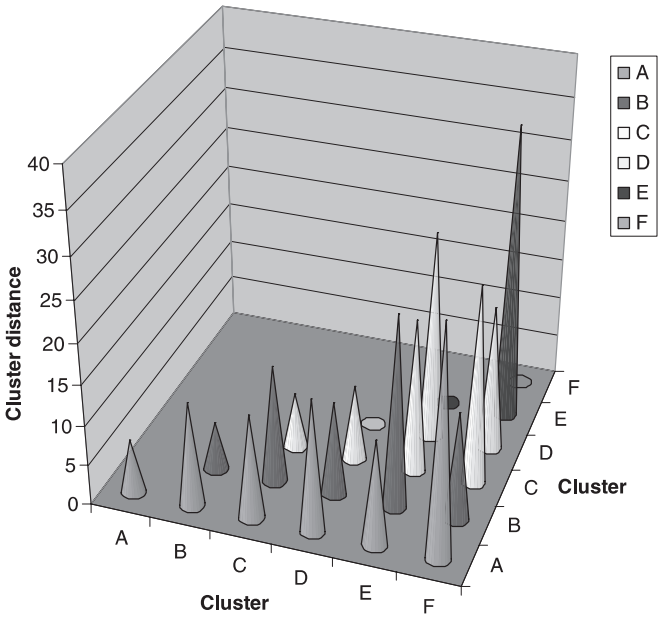

Fig.3. Cluster distances in 62 chips type jackfruit selections of hilly and coastal zones of Karnataka

Cluster means

The mean obtained for various characters from varying number of selections in each cluster gives an idea of the diversity among the clusters compared. It also helps to group clusters according to their average performance. Clusters B (52.22%), D (52.38%) and F (62.50%) were high chips yielding types while cluster E (32.00%) represents jackfruit type with a low chips recovery. Cluster A (42.69%) and C (45.72%) were found to be medium in chips yielding performance (Table 2). The maximum dry matter was noticed in the monogenotypic cluster F (31.51%) followed by cluster B (26.06%) and D (25.88%). Similarly, the starch content was found to be highest in cluster F (24.37%) followed by cluster B (19.97%). Dry matter and starch determine the yield and texture of processed products and decide the suitability of a cultivar for processing [16-18]. The amount and type of sugars in the raw material are of immense importance in processing especially into fried products [19]. There have been reports indicating the variation in the type and amount of sugars present in the jackfruits [20, 21]. In our study, the mean for reducing sugar was minimum (0.49%) with cluster C, while it was maximum (2.96%) in cluster D. The permissible upper limit of reducing sugars for processing is 0.33 % in potatoes [22] and 1.19% in bananas [23] on fresh weight basis indicating that the critical level of reducing sugars for chips making is not same for all crops.

Cluster A comprised of selections with longer bulbs (5.97 cm) and thick bulbs (0.39 cm). Bulb thickness and bulb length are important physical parameters that determine the appearance of chips and exercising slicing operation for uniform thickness of chips. Thick bulbs have to be sliced thin and vice-versa, to achieve uniform frying. Thick bulbs add to the drudgery as more number of slices has to be made from unit weight of bulbs than thin bulbs. Therefore, a balance has to be struck between bulb length and bulb thickness for exerting selection of jackfruit types suitable for chips. The TSS was minimum in cluster E (6.13°B) and maximum in cluster D (14.93°B).

In the iso-climatic region of Western Ghats, inter tree variability and formation of 5 clusters indicating physicochemical variations existing in 95 dessert types of jackfruit has been described in the previous studies [7, 14]. Another report [15] revealed that out of 13 clusters formed for genetic divergence among 44 dessert type jackfruit genotypes (belonging to different geographical regions of West Bengal, India) using Mahalanobis D^2 statistics, the Cluster XIII possessed genotypes of economic importance as means for TSS, total sugar and TSS:Acid ratio was higher than that of other clusters. An overview of clusters in context with the means of different quantitative characters in the present study reveals that high chips yielding types have also recorded high dry matter content indicating a direct relationship between these characters.

Relative contribution of characters to divergence

The relative contribution of characters clearly indicated that the recovery of chips per kg of fresh bulbs contributed maximum for divergence (62.61%) followed by TSS (15.34%), starch content (8.67%), total sugars (5.61%), bulb length (4.49%) and dry matter (2.80%). However, relatively low contribution was found to be made by bulb breadth (0.48%). This contribution is an

important consideration for the purpose of further selection.

In conclusion, it is not possible to prepare good quality chips from fruits of all jackfruit trees due to immense variations of plant types in physical and biochemical qualities of fruits. Jackfruit being indigenous and highly cross pollinated crop, displays vast diversity in the Western Ghats of India, considered as the centre of origin for cultivated jackfruit. The diversity in the natural environment is due to interaction of gene and environment. Genetic potential of all these selected ecotypes becomes clear only when they are grown in a common garden under single environment. Efforts made to study diversity in the present investigation will help in grouping the selections based correlation matrix, although they do not differentiate the contribution of environment and genetic make up on the observed performance of jackfruit selections.

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