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Influence of physico-chemical parameters of jackfruit bulbs on chips quality

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Abstract

Jackfruit chips add variety to 'salty snacks', a popular group of food item. However, the quality of finished product depends on the quality and suitability of raw material. In this work, 34 jackfruit types surveyed and selected in the hilly zone of Karnataka in India were studied to find their suitability for chips. Analysis of coefficient of variance for 9 characters in chips type jackfruits revealed a greater variability in the zone. Flake thickness, bulb length, TSS, total and reducing sugars exhibited a considerable amount of variation. Those jackfruit selections found organoleptically superior in the present study for chips making had a range for reducing sugars from 0.87 per cent (SRS-26) to 2.17 % (SRS-4). Starch content and dry matter determine the yield of processed products. Although, these parameters expressed a lower level of variation among the selections, the high chips yielding selection SRS-3 (56.00%) was associated with maximum dry matter content (27.50%). Hence, these parameters should be taken into account along with flake thickness, bulb length, TSS and reducing sugars while selecting the jackfruit types for improving yield and quality of chips.

Key words: Jackfruit, Selections, Variability, Chips, Bulbs, Sugar, Starch, Dry matter, Recovery

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.) is native to India and grows wild in the rain forests of Western Ghats of India (Reddy *et al*., 2004). Western Ghats, a rich source of biodiversity for a number of plant species, harbours a wide diversity of jackfruit trees. Jackfruit is also commonly grown in Burma, Malaysia and to a considerable extent in Brazil (Samaddar, 1985).

The popularity of jackfruit as a commercial crop is very meager 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 (Samaddar, 1985).

Jackfruit is not easy to eat out of hand owing to difficulty in separating fruit bulbs from rind. This difficulty has its origin in morphological and/or biochemical hindrances associated with the fruit. Further, the fruit in the fresh form is not liked by many due to its intense flavour (Bhatia, 1953). 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 (Roy, 2001).

Interestingly, it is not possible to convert fruits of all jackfruit trees into a variety of products due to immense variations of plant types in physical and biochemical qualities of fruits. Fruits of some jackfruit trees suitable for dessert purpose may not be appropriate for making chips due to variation in their biochemical composition. The scientific information on the aspect of jackfruit chips making is almost nil. Hence, an attempt has been made to address this part considering potato and banana crops. Ample of studies indicate the suitability of certain varieties and maturity stage of crop for chips making in potato (Misra *et al*., 1993, Gaur *et al*., 1998; Pandey *et al*., 2000; Pandey *et al*., 2001;) and banana (Shere *et al*., 1993; Wanna-Ammawath *et al*., 2001; Narayana *et al*. 2002).). In potato tubers, even morphological features such as tuber shape, size and the depth of the eyes are also the deciding characters for their suitability for processing (Verma, 1995). The crops having high dry matter are considered ideal for chipping and high dry matter content has been associated with mealiness, crispness and reduced oil uptake in chips (Grewal and Uppal, 1989 and Marwaha, 2000 in potato; Olorunda, 1993 and Shere *et al.*, 1993 in banana).

Sugars are of immense importance in potato processing, especially in fried products (chips and French fries). Chips or French fries prepared from potatoes containing larger amount of reducing

sugar (glucose and fructose) usually become brown or black and are unacceptable to the consumers. Glucose and fructose combining with other components (amino acids) result in the dark colour of the Chips or Fries. This reaction is known as Maillard reaction, occurs when the moisture content is low and the temperature is high, occurring towards the end of frying (Verma, 1995). Marwaha (2000) came across very low reducing sugar content in exotic potato cultivars (64-80 mg/100 g fruit weight) as compared to the Indian cultivars (158-285 mg/100 g fruit weight). A large variation in total free sugars was observed at the same maturity stage of jackfruits collected from different geographical locations (Rahman *et al*., 1999). In the mature but unripe jackfruit, glucose and fructose content were 2.9 per cent and 0.8 per cent respectively (Selvaraj and Pal, 1989).

Starch content of potato tubers determines the texture of processed product and is positively correlated with dry matter. The starch content ranged between 9.6 and 14.1 per cent for new potato varieties (Kufri Ashok, Kufri Jawahar, Kufri Pukharaj and Kufri Sutlej) and it was about 3.4 to 34.1 per cent lower than the control variety Kufri Jyoti (14.6%) (Uppal, 1999). Between the two varieties (Pisang Abu and Pisang Nangka) of banana tried for chips making, 'Abu' had a higher carbohydrate content than Nangka both at 'green' and 'trace of yellow' stages. Sensory evaluation showed that chips prepared from Abu were superior when compared to those from Nangka (Wanna-Ammawath *et al*., 2001). Rahman *et al*., (1999) observed a wide variation in the starch content of jackfruits collected from different locations.

In North Canara and South Canara districts of Karnataka (situated in Western Ghats), people have locally identified some jackfruit trees suitable for different uses or products. However, no standard jackfruit type suitable for making chips exists so far. Western Ghats, the treasure house of wide diversity of jackfruit, provides ample opportunities for survey, collection and evaluation of fruit quality and to identify the types suitable for chips purpose. Product diversification in jackfruit helps in popularizing the fruit among the masses as it removes difficulty in separating the bulbs from rind. Therefore, in the present investigation an effort was made to study the jackfruit diversity and to explore the variability in physico-chemical parameters in chips purpose jackfruit selections.

Material and methods

Jackfruit types used for the study were selected based on a survey conducted with the assistance of farmers, fruit merchants, Officials of State Department of Horticulture and Forestry

of the region, Government of Karnataka, India. The district of Western Ghats region of Karnataka covered for the study included Uttara Kannada falling in Hilly Zone, an agro-climatic region of the state. The jackfruit selections studied for chips purpose are given with location and code in Table 1.

Table 1. List of chips purpose jackfruit selections studied from hilly zone of Karnataka in India

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

Three fourth to fully mature (but unripe) fruits were harvested for chips making. Three fruits were selected and observed for each jackfruit type covered in the present study. Each fruit was considered as a replication. The preparation of chips was carried out on the day of harvest itself.

Methodology for preparation of chips

The selected fruits from each selection were cut along their equatorial axis with the help of a sharp sickle or fruit cutting tool smeared with edible oil. The bulbs were then carefully separated from the rind and collected in a basket. After the removal of seeds from the bulb, flakes (bulbs without seed) were longitudinally sliced manually with the help of folk slicer (*Eelige mane*) to a thickness of about 0.5 cm. Jackfruit flake slices were then fried in edible groundnut oil at 180°C till a rattling sound was heard. Chips thus prepared were taken in a vessel and immediately mixed with standardized masala (salt and spice) mixture.

Salt : 300 g
Chilli powder : 180 g
Turmeric powder : 72 g
Asafoatida : 5 g

Two teaspoon full of the above mixture (about 18 g) was mixed to chips prepared from one kg of fresh slices. Chips were then allowed to cool for 5 minutes before being packed in 200 gauge PE bag for further evaluation in the laboratory. The methodology for chips was standardized following the method existing in North Canara district (Hegde, 2003).

Observations

A. Physical parameters

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. The dry matter percentage was calculated by the following formula (Ranganna, 1986).

$$\text{Dry matter} = \frac{\text{Total dry weight of sample}}{\text{Total fresh weight}} \text{x}\, 100$$

c. Chips recovery

The recovery of chips from each selection was worked out by taking the weight of fresh slices and the weight of fried chips immediately after frying and before packing.

$$\text{Chips recovery}\,(\%) = \frac{\text{Fried chips weight}}{\text{Fresh slices weight}} \text{x}\, 100$$

B. Biochemical parameters

a. Total soluble solids (TSS)

The juice extracted by squeezing the homogenized fruit pulp through muslin cloth was used to measure the TSS. It was determined by using ERMA hand refractometer for each entry and replicated thrice and the mean was expressed in °Brix after temperature corrections.

b. Total and Reducing sugars

The total and reducing sugar content of the pulp was determined by Dinitrosalicylic acid (DNSA) method (Miller, 1972). The values of the total sugars and reducing sugars were determined and expressed in percentage on fresh weight basis.

c. Starch

The amount of starch was determined by following the standard method and the value was expressed in percentage of starch on fresh weight basis (Ranganna, 1986).

Results and discussion

The objective of the investigation was to find out the jackfruit selections suitable for chips making with the ideal physico-chemical parameters. The results are discussed below.

Physical characters of Bulbs

Among the physical parameters of bulbs studied, variation was remarkable for flake thickness (25.71%) followed by bulb length (18.36%) and bulb breadth (16.27%). The variability for flake thickness showed a range from 0.17 cm and 0.60 cm with a mean thickness of 0.35 cm (Table 2). The flake thickness was found to be maximum in UKY-12 (0.60 cm) followed by SRS-5 (0.52 cm) and SRS-31 (0.49 cm) where as minimum flake thickness was observed in the selections SRS-6 (0.17 cm), SRS-13 (0.21 cm) and SRS-28 (0.23 cm) (Table 2). Flake thickness and bulb length are important physical parameters that determine the appearance of chips and exercising slicing operation for uniform thickness of chips. Thick flakes have to be sliced thin and vice-versa, to achieve uniform frying. Thick flakes add to the drudgery as more number of slices has to be made from unit weight of flakes than thin flakes. In the present study, bulb length showed a range from from 3.76 cm (SRS-4) to 7.57 cm (UKY-10), while the flake thickness varied from 0.17 cm (SRS-6) and 0.60 cm (UKY-12). Therefore, a balance has to be struck between bulb length and flake thickness for exerting selection of jackfruit types suitable for chips. Round or round-oval tubers are ideal for potato ‘chips’ and long-oval tubers for ‘French fries’ to obtain a

large number of pieces of the desired length. Shallow-eyed potatoes are preferred for processing since the peeling losses are higher in deep-eyed potatoes (Verma, 1995).

Table 2. Variations in physical characters of bulbs in chips type jackfruits of hilly zone of Karnataka in India

Sl. No	Selection	Bulb length (cm)	Bulb breadth (cm)	Flake thickness (cm)
1	SRS-1	5.23	3.20	0.33
2	SRS-2	4.16	2.46	0.33
3	SRS-3	4.13	2.91	0.26
4	SRS-4	3.76	2.71	0.30
5	SRS-5	6.50	4.23	0.52
6	SRS-6	5.53	2.33	0.17
7	SRS-7	5.06	3.06	0.35
8	SRS-8	5.70	2.96	0.38
9	SRS-12	5.83	3.80	0.47
10	SRS-13	4.60	2.96	0.21
11	SRS-14	5.23	2.93	0.30
12	SRS-15	4.50	3.26	0.35
13	SRS-16	5.63	3.10	0.33
14	SRS-17	5.00	2.86	0.43
15	SRS-18	6.46	3.46	0.36
16	SRS-19	6.23	3.96	0.36
17	SRS-25	6.20	3.70	0.28
18	SRS-26	5.73	2.90	0.30
19	SRS-27	5.20	3.10	0.32
20	SRS-28	4.80	3.47	0.23
21	SRS-29	5.13	3.00	0.28
22	SRS-30	6.33	3.77	0.44
23	SRS-31	7.13	4.37	0.49
24	UKY-2	6.43	3.20	0.29
25	UKY-3	5.33	3.23	0.35
26	UKY-5	4.03	3.33	0.29
27	UKY-6	5.33	3.33	0.32
28	UKY-8	7.33	3.50	0.34
29	UKY-10	7.57	3.87	0.37
30	UKY-11	5.00	4.63	0.45
31	UKY-12	7.33	4.03	0.60
32	UKY-13	6.00	4.37	0.44
33	UKY-14	4.37	3.47	0.31
34	UKY-31	4.20	3.60	0.35
Mean		**5.50**	**3.38**	**0.35**
CV (%)		**18.36**	**16.27**	**25.71**
SD		**1.01**	**0.55**	**0.09**

CV=Coefficient of variance, SD = Standard deviation

Biochemical traits

Total sugars and reducing sugars are among the biochemical parameters that elicited a large variation in the pool of jackfruit selections. Hilly zone jackfruits considered for chips indicated a variation of 61.46 per cent for total sugars and 55.77 per cent for reducing sugars (Table 3). The variability for total sugars was ranging from 1.03 (UKY-3) to 9.12 (UKY-11) per cent with a mean of 3.71 per cent (Table 3). Similarly, the selections SRS-13 (3.33%), UKY-14 (3.10%) and UKY-11 (3.08%) recorded maximum reducing sugars, while the minimum reducing sugar content was noticed in UKY-3 (0.30%) followed by SRS-27 (0.46%) and SRS-29 (0.49%) (Table 3).

However, mean values for both total (3.71%) and reducing sugars (1.56%) indicate their closeness to lower side of the range. Hence, few clones with inherently high sugar content (SRS-13, UKY-11, UKY-13 and UKY-31) and the difference in eco-geographic origin of different jackfruit types might have resulted in wide variation. Further, fruits were selected at ¾th to fully mature (but unripe) stage for chips making and this difference in stage of maturity might have also contributed for large variation seen in these parameters. Sugars are of immense importance in fried potato products (Verma, 1995). The permissible upper limit of reducing sugars in potatoes for processing is 0.33 per cent on fresh weight basis (Brunton and Wilson, 1978). Several studies have reported a high variation in the reducing sugar content of potato varieties (Misra *et al*., 1993; Marwaha, 1998b and Marwaha, 2000). Nendran bananas at 95 days of maturity had 1.19 per cent reducing sugars and gave chips of normal size, colour, texture, aroma and taste than at 75 days or 100 days (Satyavati *et al*., 1978). These reports reveal that the critical level of reducing sugars for chips making is not same for all crops. Those jackfruit selections found organoleptically superior in the present study for chips making had a range for reducing sugars from 0.87 per cent (SRS-26) to 2.17 per cent (SRS-3) (Fig.1). However, judging the right stage of maturity in jackfruits is a horrendous task unlike whole plot of potatoes or bunch of bananas where the crop is harvested on the basis of days after sowing or days after shoot emergence.

Starch content, dry matter and chips yield recorded almost a similar level of variation in the jackfruit selections. Among all the chips type jackfruit selections, maximum starch content was noticed in SRS-27 (21.17%) followed by SRS-15 (21.13%) and UKY-5 (20.80%). The selections with maximum dry matter content were SRS-3 (27.50%), SRS-15 (26.83%) and SRS-27 (26.18%) and the types associated with highest chips recovery were SRS-3 (56.00%), SRS-27 (53.75%) and SRS-15 (53.33%) (Table 4).

Table 3. Variations in biochemical qualities of bulbs in chips type jackfruits of hilly zone of Karnataka in India

Sl. No	Selection	TSS (°Brix)	Total sugars (%)	Reducing sugars (%)
1	SRS-1	9.90	5.26	2.68
2	SRS-2	10.80	6.08	2.83
3	SRS-3	9.00	5.02	2.46
4	SRS-4	8.60	4.86	2.17
5	SRS-5	6.13	3.10	1.22
6	SRS-6	5.20	1.28	0.58
7	SRS-7	9.53	4.96	2.24
8	SRS-8	9.03	4.80	2.13
9	SRS-12	7.06	3.72	1.47
10	SRS-13	13.20	7.08	3.33
11	SRS-14	5.20	1.30	0.51
12	SRS-15	8.46	3.78	1.39
13	SRS-16	6.46	3.17	1.61
14	SRS-17	7.53	3.83	1.49
15	SRS-18	5.66	1.90	0.86
16	SRS-19	7.70	3.82	1.58
17	SRS-25	5.00	2.20	1.25
18	SRS-26	4.30	1.96	0.87
19	SRS-27	6.40	1.18	0.46
20	SRS-28	7.10	1.11	0.61
21	SRS-29	6.13	1.21	0.49
22	SRS-30	3.93	1.98	0.82
23	SRS-31	4.40	2.23	1.00
24	UKY-2	9.47	4.83	2.03
25	UKY-3	5.01	1.03	0.30
26	UKY-5	7.53	2.82	1.23
27	UKY-6	7.40	2.71	1.11
28	UKY-8	7.45	2.90	1.04
29	UKY-10	6.20	2.02	0.96
30	UKY-11	14.00	9.12	3.08
31	UKY-12	8.47	4.21	1.89
32	UKY-13	7.80	2.73	1.33
33	UKY-14	13.37	9.03	3.10
34	UKY-31	14.00	9.03	3.01
Mean		**7.87**	**3.71**	**1.56**
CV (%)		**34.69**	**61.46**	**55.77**
SD		**2.73**	**2.28**	**0.87**

Starch content of potato tubers determines the texture of processed product and positively correlated with dry matter (Uppal, 1999). Dry matter determines the yield and texture of processed products and decides the suitability of a cultivar for processing (Grewal and Uppal,

1989 and Marwaha, 2000 in potato; Olorunda, 1993 and Shere *et al*., 1993 in banana). Potatoes having more than 20 per cent dry matter are considered good for processing into chips (Brody, 1969).

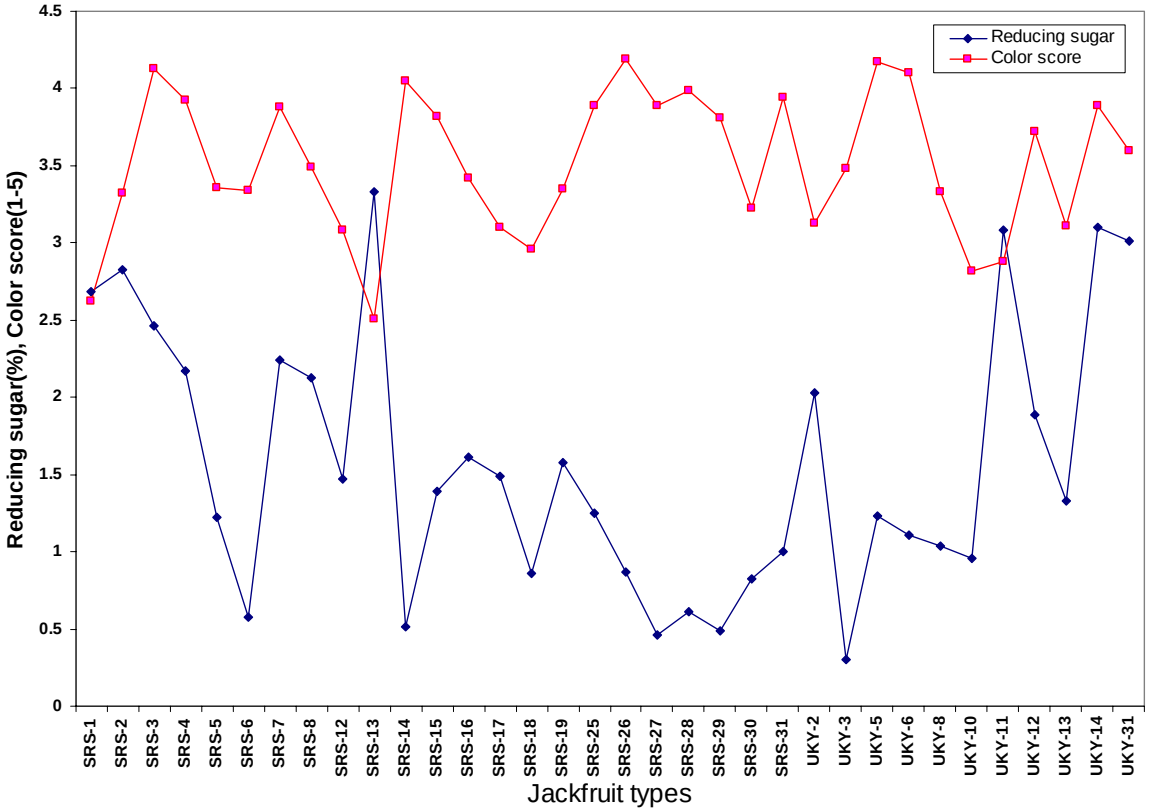

Fig.1 : Influence of reducing sugar content of bulbs on color of Jackfruit chips

Several workers have reported a variation in starch and dry matter content with varieties and stage of maturity (Misra *et al*., 1993; Verma, 1995; Marwaha, 1998b and Uppal, 1999 in potatoes; Satyavati *et al*., 1978; Olorunda, 1993 and Shere *et al*., 1993 in banana). Location of cultivation also affects the dry matter content (Verma, 1995). In the present study starch, dry matter and chips recovery in the jackfruit types belonging to hilly zone varied from 11.02 (UKY-31) to 21.17 (SRS-27) per cent, 17.08 (SRS-29) to 27.50 (SRS-3) per cent and 32.00 (SRS-29) to 56.00 (SRS-3) per cent respectively (Table 4). Hence, the variations observed for these traits in the present investigation might be due to plant type, maturity stage and the geographical location. Here, jackfruit clones with high dry matter and starch content in their bulbs have to be considered for operating selection procedure to get increased yield and quality of chips.

Table 4. Variations in values of starch, dry matter of bulbs and chips recovery in different chips type jackfruits of hilly zone of Karnataka in India

Sl. No	Selection	Starch (%)	Dry matter (%)	Recovery (%)
1	SRS-1	23.26	26.01	50.00
2	SRS-2	21.16	25.11	49.00
3	SRS-3	20.92	27.50	56.00
4	SRS-4	26.09	23.22	47.22
5	SRS-5	29.17	20.50	42.00
6	SRS-6	31.60	21.03	40.00
7	SRS-7	24.62	25.50	52.00
8	SRS-8	23.90	21.10	40.00
9	SRS-12	31.04	20.50	42.00
10	SRS-13	18.02	20.26	41.76
11	SRS-14	30.12	22.05	46.00
12	SRS-15	26.13	26.83	53.33
13	SRS-16	31.86	20.89	42.00
14	SRS-17	26.44	24.12	48.00
15	SRS-18	30.12	21.53	40.00
16	SRS-19	26.66	24.31	48.00
17	SRS-25	29.01	22.63	46.63
18	SRS-26	29.13	24.33	48.97
19	SRS-27	29.17	26.18	53.75
20	SRS-28	21.88	20.50	42.00
21	SRS-29	28.76	17.08	32.00
22	SRS-30	30.12	19.10	38.00
23	SRS-31	32.17	21.13	40.00
24	UKY-2	21.23	20.98	39.48
25	UKY-3	29.16	21.50	40.00
26	UKY-5	29.80	25.90	52.94
27	UKY-6	31.42	22.87	46.87
28	UKY-8	29.61	24.10	48.00
29	UKY-10	30.11	22.38	43.88
30	UKY-11	16.13	24.61	51.11
31	UKY-12	26.12	24.39	48.39
32	UKY-13	29.92	22.99	44.49
33	UKY-14	19.12	22.67	46.67
34	UKY-31	19.02	21.83	43.33
Mean		**17.34**	**22.81**	**45.41**
CV (%)		**16.61**	**10.33**	**11.78**
SD		**2.88**	**2.36**	**5.35**

Conclusion

It is not possible to convert bulbs from fruits of all jackfruit trees into chips due to immense variations of plant types in physical and biochemical qualities of fruits. Analysis of coefficient of variance for 9 characters in chips type jackfruits of hilly zone revealed a greater variability. Flake thickness, bulb length, TSS, total and reducing sugars exhibited a considerable amount of variation. Starch content and dry matter are associated with the yield of processed products. Hence, these parameters should be taken into account along with flake thickness, bulb length, TSS and reducing sugars while selecting the jackfruit genotypes for improving yield and quality of chips.

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