



ISSN (E): 2277- 7695  
ISSN (P): 2349-8242  
NAAS Rating: 5.03  
TPI 2020; 9(12): 354-357  
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[www.thepharmajournal.com](http://www.thepharmajournal.com)  
Received: 19-08-2020  
Accepted: 03-10-2020

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## Physical and nutritional properties of jackfruit at different stages of maturity

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### Abstract

Popular fruit having restricted usage in small segment of the country, the jackfruit was taken for the study at different levels of maturity with objective to evaluate the physical and nutritional characteristics at different stage of maturity. Results showed that length (11.7 cm 47.18 cm and 44.20 cm in immature, mature and ripe fruit respectively), breadth (13.35cm, 26.12cm and 25.51 cm in immature mature and ripe fruit respectively) of jackfruit significantly differs at all levels of maturity. Weight of edible portion was significantly different in all three stages, highest edible portion was present in mature jackfruit (4.66kg). Jackfruit contains highest protein (4.36%) and ash (3.53%) at mature level. Immature contains good amount of crude fat (4.16%) and calcium (55.30 mg/100g). ripe fruit found to be rich in crude fibre (10.10%) and 93.64% of total carbohydrate. Jackfruit is rich in nutrient in all the stages of maturity.

**Keywords:** Jackfruit, maturity, proximate composition, minerals

### Introduction

India is second largest producer of fruits and vegetables next to China (Arora, 2005) [2]. Jackfruit (*Artocarpus heterophyllus*), a tropical fruit being native to Southeast Asia (Boning, 2006) [3] is widely grown and consumed in India. The fruit can be found across the globe except in desert areas. It is largest known tree borne fruit around the world (FAO, 2012) [4], which is ignored many times due to its arduous processing. Jackfruit is popular among growers but underutilized fruit which can be used at any stage from blooming to ripening. Major usage is in the form of dessert when ripe and vegetable when unripe. Other uses include fodder, timber, fuel and medicinal and industrial products. Lush green fruit in immature tender form is used in the preparation of vegetables, pickle, chips etc. while, aromatic, pleasant ripe bulbs are used for table purpose and to prepare delicacies like papads, jams, custards, ice creams, other sweets as well as used in daily preparations. It is rich in proteins, carbohydrates, vitamins and minerals, and also affordable and readily available supplement to our staple food. Immature and mature fruits possess many health promoting components compared to ripe (Trindade and Lopes, 2006) [15]. The value of its versatility is enhanced by its availability during the monsoon period when the supply of other vegetables is low (Singh *et al.*, 1963) [13]. Information on variation in nutritional constituents and dietary significance at different stage of maturity of this fruit is scanty. Hence, the present study was planned to evaluate the physical and nutritional characteristics of jackfruit at different stage of maturity.

### Material and Methods

The fully grown jackfruit trees were identified on the campus of University of Agricultural Sciences and nearby areas of Dharwad, Karnataka. Jackfruit in three different stages of maturity was procured from specific trees situated on the campus during the months of January to June. Horticulturists were consulted to understand the maturity for different stages of growth. Thus a total of 30 jackfruits of three different stages viz., immature, mature and ripe (7, 10-12 and 14-16 week after anthesis respectively) were collected. The samples were immediately cleaned, washed dried and kept at safe place for further analysis.

### Physical properties of whole fruit at different stages of maturity

The whole fruits were used for measuring physical properties such as weight, length, breadth, lengthwise circumference, and width wise circumference, weight of edible portion and weight of seed. Ten fruits each, at different stages of maturity were selected randomly. Length of ten selected jackfruits was obtained by placing the fruit lengthwise on paper and the ends marked.

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The measurements were recorded in centimeter using a scale and average was calculated.

Breadth of the jackfruit was obtained by placing ten selected fruits breadth wise on a paper and the ends marked. The measurements of breadth were recorded using a scale and average calculated in centimeter.

Length wise circumference of the ten selected fruits was measured by passing flexible non stretchable tape around the central part of the fruit along the length. Measurement was expressed in centimeter.

Width wise circumference of the ten selected fruits was measured by passing flexible non stretchable tape around upper, middle and lower part of the fruit along the breadth. The average of three measurements for each fruit was calculated and expressed in centimeter.

Ten individual fruits of each stage of maturity were selected randomly and weighed using the digitalized weighing balance, average was calculated and expressed in kilo grams (kg).

To assess edible portion, immature jackfruits were peeled and edible portion was weighed. For matured and ripe stage, selected ten fruits were cut open and bulbs, seeds, rinds, perianth and core separated. The bulbs were weighed as edible part using digital weighing balance and expressed in kilograms per fruit. The seeds were weighed separately, average calculated and expressed in kilogram per fruit.

#### Proximate analysis and mineral composition of the jackfruit at different stages of maturity

The selected jackfruit of three stages were analysed for proximate composition viz., moisture, protein, ash, crude fat, crude fibre using AOAC procedure. Moisture free samples were used for protein, ash and crude fat analysis while, moisture and fat free samples were employed for crude fibre estimation. Total carbohydrate was computed by deducting sum of moisture, protein, fat and ash from 100. To compute available carbohydrate crude fiber was also deducted. Estimation of calcium was carried out by titrimetric method (Oser, 1965) [9]. The trace elements (iron, zinc, copper and manganese) were estimated using Atomic Absorption Spectrophotometer (model: AAS GBS Avanta) after subjecting the sample to wet digestion using triacid mixture (Anon., 2000) [1].

#### Statistical analysis

Statistical analysis was carried out using IBM SPSS software version 18.0. Analysis of variance (one way) was used to assess the significance. Duncan's new multiple range test (DMRT) was used to determine significant differences. Wherever significant results obtained the critical difference test was used (Steel and Torrie, 1960) [14].

#### Results and discussion

##### Physical properties of jackfruit at different stages of maturity

The physical properties of different stages of jackfruit viz. immature, mature and ripe are presented in Table 1. The average length and breadth of immature jackfruit (11.7 cm and 13.35 cm respectively) were lesser than mature (47.18 cm and 26.12 cm respectively) and ripe fruits (44.2 cm and 25.51 cm respectively). The average length-wise circumference of the three stages was 53.63cm, 94.04cm and 94.08cm respectively whereas the width-wise circumference was 80.95cm, 70.04cm and 74.47cm. ANOVA test indicated that length, breadth and length-wise circumference were significantly lower in immature fruit, while, mature and ripe fruits were on par with each other. The increase in length, breadth and lengthwise circumference with simultaneous decrease in widthwise circumference on maturity indicates that fruit grows lengthwise resulting in changes in shape. The weight, diameter, both lengthwise and widthwise circumferences and other physical properties change with maturation and ripening (Shamsudin, *et al.*, 2009) [11]. Approximately 30 percent of the jackfruit was inedible in the immature stage and remaining 70 percent was edible. Similarly, the percentage of edible and inedible portions of mature and ripe jackfruit was 56.96 and 32.76; 28.51 and 59.28 respectively. Increase in peel thickness, rags, perianth and other parts leads to increase in inedible portion. The seeds were not mature enough to be separated in the immature stage. The average weight of seeds in mature and ripe stages was 0.84 kg and 0.92 kg respectively. Seed weight of mature and ripe fruit did not differ significantly. However, not much variation between mature and ripe fruits was observed which indicates that variations are detectable in internal composition rather than size; and external morphological growth was completed by mature stage. The results of the present study are in accordance with that of many scientists (Haq, 2006; Sidhu, 2012 and Mishra, *et al.*, 2018) [5, 12, 7].

**Table 1:** Physical properties of jackfruit at different stages of maturity

Properties	Stages of maturity of jackfruit			F Value	S.Em	CD
	Immature	Mature	Ripe			
Length (cm)	11.7±1.13 <sup>b</sup>	47.18±5.15 <sup>a</sup>	44.20±4.36 <sup>a</sup>	247.672	1.250	3.629*
Breadth (cm)	13.35±1.31 <sup>b</sup>	26.12±1.46 <sup>a</sup>	25.51±1.44 <sup>a</sup>	261.201	0.445	1.293*
Length wise circumference (cm)	53.63±1.21 <sup>b</sup>	94.04±6.84 <sup>a</sup>	94.08±0.96 <sup>a</sup>	743.737	1.315	3.818*
Width wise circumference (cm)	80.95±0.83 <sup>a</sup>	70.04±1.49 <sup>c</sup>	74.47±0.70 <sup>b</sup>	3136.018	0.526	1.527*
Weight of seed (kg)	NF	0.84±0.06 (10.26)	0.92±0.00 (12.20)	1613.482	0.014	NS
Weight of edible portion (kg)	2.05±0.6 <sup>b</sup> (69.25)	4.66±0.32 <sup>a</sup> (56.96)	2.15±0.34 <sup>b</sup> (28.51)	63.096	0.177	0.515*
Weight of inedible portion	0.91±0.05 <sup>c</sup> (30.75)	2.68±0.56 <sup>b</sup> (32.76)	4.47±0.45 <sup>a</sup> (59.28)	8.199	0.402	1.169*

**Note:** values are average of ten fruits, NF: seeds not mature enough to be separated, Figures in parenthesis indicate percentages, S.Em: Standard Error Mean, CD: Critical Difference, NS: Non-Significant, \*Significant @5%

Values with the same superscripts (a, b) in the same row are not significantly different ( $p \leq 0.01$ ).

#### Proximate composition of jackfruit at different stages of maturity

A perusal of Table 2 indicates that moisture in jackfruit in the three stages viz. immature, mature and ripe was 70.61, 68.43

and 76.20 respectively with ripe fruit having significantly higher value (76.20%) and mature having significantly lower (68.43%). The moisture content decreased with maturity and increased again during ripening. Similar results were observed by Ong *et al.* (2006) [8]; Ranasinghe and Marapana, (2019) [10]. Protein content was found to be higher (4.36%) in mature followed by immature (3.42%). Minimum protein content was

found in ripe fruit (1.61%). Crude fat values (%) for the three stages were 4.16, 2.43 and 1.76 respectively, being significantly maximum in immature and minimum in ripe fruits. The ash and crude fiber contents of immature and ripe fruits were statistically on par with each other (3.15 & 2.99% and 9.96 & 10.10% respectively). However, crude fiber was lower and ash was higher in mature fruits than other two stages. The total and available carbohydrates were significantly higher in ripe (93.64 & 83.54% respectively)

followed by mature (89.68 & 82.52% respectively) and immature (89.27 & 79.31% respectively) fruits. The energy content (kcal) in the three stages were found to be 368, 369 and 357 respectively, mature having maximum and ripe having minimum value. In the present study, protein, ash, carbohydrate and energy contents of mature fruits were higher than other two stages (Table 2), while the moisture and crude fiber contents were lower.

**Table 2:** Proximate principles (dwb) of jackfruit at different stages of maturity

Proximate principles (%)	Stages of maturity of jackfruit			F Value	S.Em	CD
	Immature	Mature	Ripe			
Moisture	70.61±0.0 <sup>b</sup>	68.43±0.08 <sup>c</sup>	76.20±42.2 <sup>a</sup>	313.07	0.228	0.789*
Protein	3.42±0.08 <sup>b</sup>	4.36±0.06 <sup>a</sup>	1.61±0.02 <sup>c</sup>	2126.07	0.025	0.089*
Crude Fat	4.16±0.05 <sup>a</sup>	2.43±0.04 <sup>b</sup>	1.76±0.05 <sup>c</sup>	11.645	0.065	0.227*
Ash	3.15±0.02 <sup>b</sup>	3.53±0.01 <sup>a</sup>	2.99±0.16 <sup>b</sup>	1665.52	0.036	0.126*
Crude fiber	9.96±0.01 <sup>a</sup>	7.16±0.13 <sup>b</sup>	10.10±0.2 <sup>a</sup>	76.382	0.179	0.622*
TC	89.27 ±0.02	89.68±0.02	93.64±0.03	52011.04	0.012	0.372*
AC	79.31±0.15	82.52±0.25	83.54±0.05	44301.79	0.057	2.58*
Energy (Kcal)	368±0.04	369±0.05	357±0.13	1574.519	0.018	2.58*

**Note:** TC: total carbohydrate, AC: Available carbohydrate Values are the mean of three replications, S.Em-Standard Error Mean, CD-Critical Difference, NS-Non Significant, \*Significant @5%, Values with the same superscripts (a, b) in the same row are not significantly different (p≤0.01).

### The mineral content of jackfruit at different stages of maturity

All the minerals estimated were higher in immature jackfruit followed by mature, while ripe fruits were having lowest mineral contents (Table 7). The calcium content ranged from 36.75 to 55.30 mg/100g; iron ranged from 0.34 to 2.75 mg/100g; zinc from 0.09 to 2.44; copper from 0.20 to 2.00mg/100g. Manganese content of both mature and ripe

jackfruit was 0.36mg/100g, whereas immature fruit contained 0.94mg/100g. The mineral contents of all three stages were statistically different. On the contrary, mineral content decreased with increase in maturity and ripening (Table 3), probably due to utilization of minerals during growth. Similar results are also quoted by Jagdeesh, (2010) [6] and Haq (2006) [5].

**Table 3:** Mineral content (dwb) of jackfruit at different stages of maturity

Minerals (mg/100g)	Stages of maturity of jackfruit			F Value	SEm	CD
	Immature	Mature	Ripe			
Calcium	55.30±0.28 <sup>a</sup>	44.67±0.50 <sup>b</sup>	36.75±0.03 <sup>c</sup>	2369.84	0.19	0.66***
Iron	2.75±0.04 <sup>a</sup>	0.39±0.025 <sup>b</sup>	0.34±0.01 <sup>b</sup>	7342.07	0.02	0.06***
Zinc	2.44±0.01 <sup>a</sup>	0.19±0.019 <sup>b</sup>	0.09±0.02 <sup>c</sup>	18458.19	0.01	0.02***
Copper	2.00±0.25 <sup>a</sup>	0.24±0.02 <sup>b</sup>	0.20±0.05 <sup>b</sup>	145.39	0.09	0.30***
Manganese	0.94±0.08 <sup>a</sup>	0.36±0.03 <sup>b</sup>	0.36±0.015 <sup>b</sup>	133.30	0.03	0.11***

**Note:** Values are the mean of three replications, SEm- Standard Error Mean, CD-Critical Difference, NS-Non Significant, \*Significant @0.1%, Values with the same superscripts (a, b) in the same row are not significantly different (p≤0.01)

### Conclusion

Hence it can be concluded from the above study that all the three stages of maturity of jackfruit are significantly different to each other in shape, size, weight and circumference. Among the three stages of maturity, mature fruits were having higher nutrients compared to immature and ripe. However, higher crude fiber was recorded in ripe stage. Thus, mature fruit can serve as a source of nutrients and nutraceuticals to address the health issues.

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