International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2015): 6.391

Comparative Study of Carotenoids and Mineral Composition in Five Different Pulp Colours of Jackfruit (*Artocarpus heterophyllus Lam.)*

Shyamalamma S[1]., Vanitha P. A.[2], Priyanka S[3], Ramanjinigowda, P.H[4]

[1, 4]Professors, Dept. of Biotechnology, UAS, Bangalore, Karnataka

[2, 3]Research Fellows, Dept. of Biotechnology, UAS, Bangalore, Karnataka

Abstract: ***Jackfruit is one of the most versatile, tropical to temperate climate tolerant, underutilized evergreen tree species, found growing naturally in Western Ghats region of South as well as North Eastern Hilly regions of India. The tree has several economic uses, yields are very high, leaves are used as feed/ fodder for animals, wood has good timber value and fruits are nutritious, rich in carotenoids and minerals. The fruits exhibit varied pulp colours; among them the orange and red colour pulp has good commercial demand. Hence, a study was under taken to assess the carotenoids content and mineral composition in five different pulp colours of Jackfruit. Results revealed that, the red and orange colour pulp contained significantly higher concentrations of β -Cryptoxanthine (45.44mg/100g and 42.57mg/100g) followed by β-Carotene (44.20mg/100g and 43.14mg/100g) α -Carotene (39.40mg/100g 37.30mg/100g) and Lycopene (30.20mg/100g and 27.70mg/100g) respectively. The mineral composition analysis revealed that the potassium content was higher (326.47mg/100g) in dark yellow colour pulp followed by red colour pulp (322.70mg/100g) and orange colour pulp (216.07g/100g). However, there were no significant differences in the concentrations of sodium, manganese, zinc, iron and copper among different pulp colours. Highlights: 1) Fifteen Jackfruit genotypes with five different pulp colours were identified in Bangalore rural and Tumkur districts. 2) Two fruits from each accession were collected at maturity and ripened in the laboratory. 3) Morphological traits of pulp and other biochemical characters were recorded. 4) Fresh pulp was subjected for analysis to estimate carotenoids and mineral content.***

Keywords: Jackfruit, carotenoids, minerals, analysis

1. Introduction

Jackfruit is believed to be native of India, originated in Western Ghats of Southern India. The Jackfruit produces more yield than any other fruit tree species. (Alagiapillai *et al.,* 1996). It is widely cultivated in Malaysia, Myanmar, The Philippines, Bangladesh, Sri Lanka, Brazil, West Indies, Pakistan and other tropical countries in the world. Jackfruit is the largest edible fruit in the world and is a tropical evergreen tree. Ripe Jackfruit is very nutritious, rich in pectin and minerals like phosphorus, iron, potassium, and calcium. Ripe bulbs are full of carbohydrates, protein, ascorbic acid and carotene; the ripe fruits are used in the preparation of canned products such as nectar, jam, jelly, fruit bar, candy, etc.

Jackfruit exhibits huge variation in fruit size, shape, pulp colour, taste aroma and Total Soluble Solids (TSS). Among them the variations in pulp colour are the main criteria for commercial exploitation of the genotypes. The genotypes with orange and red colour pulp draws the attention of many consumers compared, to yellow and cream colour pulp in spite of the taste and aroma present in yellow and cream colour types. Therefore an attempt was made to quantify the variations in pulp carotenoids and mineral content, among the various pulp color of Jackfruit and their relation to nutritional value of the fruit.

Carotenoids (Pro-vitamin A) in vegetables and fruits represent the main source of vitamin A for 70-90% of people in developing countries (McLaren and Frigg, 2001). Carotenoids are fat-soluble compounds that occur naturally in fruit and vegetables (Gerster, 1997). Carotenoids are reported to be of additional importance either as antioxidants or enhancing the immune response (Schweigert *et al.,* 2001). Among carotenoids, the antioxidative properties were highest for Lycopene, β-carotene and lutein. Lycopene has the highest free radical scavenging ability, followed closely by β -cryptoxanthine and β -carotene (Miller *et al.,* 1996). Carotenoids are known to be involved in scavenging and quenching singlet oxygen molecules, especially the β -carotene is well known as an antioxidant with considerable evidence for interaction of the β -carotene with free radicals (Umesh *et al.,* 2010; Krinsky *et al.,* 2003; Palozza *et al.,* 1992; Krinsky *et al.,* 1993; Conn *et al.,* 1992). β-carotene has also been reported to the most active provitamin A pigment and known to protect against photosensitive diseases in humans (Micheline *et al.,* 1974).

Fruits contribute significant amounts of minerals to the human diet. Minerals are required for normal cellular function, haemoglobin composition, gene expression and amino acid, lipid and carbohydrate metabolism (Marisa, 2006). The Jackfruit pulp eaten as fresh and used in fruit salads has high nutritive value. Every 100 g of ripe jackfruit pulp contains carbohydrate (18.9 g), protein (1.9 g), fat (0.1 g), moisture (77%), fibre(1.1 g), total mineral matter (0.8 g), potassium (191 to 407mg), phosphorus (38 to 41mg),calcium (20 to 37mg), iron (0.50 to 1.70 mg), and vitamin-A (175 to 540 I.U), with a caloric value of 84 calories.(Jagdeesh *et al.,* 2007).Further, the nutritional composition of tender fruit has been reported by Mitra (1999) , which are usually used as vegetable. It is rich in potassium (246mg/100g), phosphorus (97 mg/100g) and calcium (50mg/100g). The mineral composition of fruits can

reflect the trace mineral content of soils in geographic region (Forster *et al.,* 2002), and varies with climate, maturity, cultivar, and agricultural practises. (Marisa, 2006).

Thus the above work was initiated to examine the differences in pulp carotenoids, mineral composition, TSS, and crude fibre contents indifferent pulp colours of jackfruit (cream, light yellow, dark yellow, orange and red).

2. Materials and Methods

1. Selection of Jackfruit genotypes

Surveys were conducted to identify Jackfruit genotypes with distinct pulp colours in different locations of Bangalore rural and Tumkur districts (Table I). Three genotypes from each pulp color viz, cream, light yellow, dark yellow, orange and red were identified. Two fruits from each genotype were harvested at full maturity and brought to the laboratory for further analysis. The fruits were cut opened and the various flake characteristics were recorded. For estimation of carotenoids content 10 to 15 flakes from each genotype were packed in black polythene covers and stored at -20^0 C.

2. Total Soluble Solids (TSS^o Brix)

The juice was extracted from fresh fruit pulp by squeezing the homogenized fruit pulp on to a Hand Refractometer (Erama, Japan) to measure the TSS and was expressed in ^{o}Brix.

3. Estimation of pulp carotenoids content

The Protocol outlined by Chandrika *et al*. (2005) was followed. Fifty grams of Jackfruit pulp was cut into small pieces and homogenized in a mechanical blender into a fine paste by adding cold acetone and celite. The extract was filtered using Whatman filter paper 1. The grinding and filtration was repeated until the pulp was colourless. The final extract was mixed with petroleum ether in 1:1 ratio in a separatory funnel and the mixture was allowed to separate into two layers. The upper supernatant was collected and a pinch of anhydrous sodium sulphate was added. Then the sample was read in U. V. Spectrophotometer (Varian Cary 50 Bio Australia) at different wave lengths for estimation of different carotenoids.

4. Pulp mineral analysis

The analysis for mineral composition in fruit pulp was carried out at the Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Bangalore.

Fruit samples (25 g) were dried in an oven at 60^{0}C and ground into a fine powder in a mixer. The dried sample (3 g) was taken and burnt into ashes in a muffle furnace at 600^0 C for 3 hours (until a whitish ash was obtained, indicating the complete elimination of organic material) and acid extracted, the acid digested sample was filtered through filter paper (Whatman filter paper 125mm) and the volume was made upto 100ml with distilled water in a volumetric flask. Minerals were estimated with the use of Atomic Absorption Spectrophotometer (AAS) (Perklin Elmer, U.S.A). The instrument was calibrated with the standard solutions containing known amount of the mineral being determined, using analytical reagents; the results were computed and expressed as mg/100g pulp.

3. Results and Discussion

A. Morphological traits of Jackfruit genotypes

The Jackfruit genotypes collected from different locations were analysed for morphological traits. The Total Soluble Solids (TSS) content recorded among the fifteen genotypes varied from 20^{o}Brix to 32^{o}Brix. It was lower in BHT 5 and higher in TDT 1, the variations in TSS content could be mainly due the characteristic of a genotype to assimilate the sugars and also the climate of the place where the plant is located, maturity, soil type and fertility etc. Similar reports on variations in Vit-C and mineral content in banana and papaya types has been reported (Marisa, 2006; Mozafar, 1994; Shewfelt, 1990).

B. Carotenoid Composition

Major attraction of Jackfruit lies in its pulp colour and taste. The dark pulp colour types fetch better prices in the market than light colour flakes. Thus a study was initiated to assess the pulp carotenoids composition in five different pulp colours of Jackfruit.

The composition of four different carotenoids varied significantly (Table 2). The β cryptoxanthine content was significantly higher (45.44 mg and 42.57mg/100g) in red and orange colour pulp, followed by β carotene (44.20mg and 43.14mg/100g), α-carotene (39.40mg and 37.30mg/100g) and Lycopene (30.20mg and 27.70mg/100g) respectively. Whereas the above carotenoids composition was significantly lower in dark yellow, light yellow and cream colour pulp. The overall composition of carotenoids was higher (43%) in orange colour pulp followed by red (42%) and dark yellow (11%). Thus, the genotypes with range, red and dark yellow colour pulp can be used for developing nutraceutical drinks and water soluble powders from the dehydrated pulp of Jackfruit. Most of the carotenoids possess antioxidant capacity and known to possess the property of free radical scavenging.

These variations in carotenoids content could be influenced by the growing conditions, variety/cultivar, geographical location, ripeness, picking to market conditions. Further it also been reported that the red pepper used as paprika has been reported to have higher carotenoids content than the other varieties (Almela *et.al.* 1991). The carotenoids composition has been reported to vary within populations as reported by Speek *et.al,* (1988) in different Thai vegetables.

The nutritional importance of carotenoids has been related to their role as precursor of vitamin A and only few carotenoids are known to posses pro vitamin A activity, these include α-carotene, β carotene,β crypto xanthine but not lycopene (Erdman *et al*. 1998).

C. Mineral Composition

The present study on mineral composition in different Jackfruit pulp color revealed that the concentration of potassium was significantly higher (326.47mg/100g) in dark yellow color pulp followed by red color pulp (322.7 mg/100g) compared to orange (216.07mg/100g), light

yellow (212.87mg/100g) and cream color pulp (196.86mg/100g). There were no significant differences in concentration of sodium among different pulp colors and it varied from 1.8 g/100g in cream color pulp to 2.84 mg/100g in red color pulp, where as the composition of manganese, zinc, iron and copper among different pulp colors did not show much variations. Similar reports have been made by Tang *et al.*(2013); Srikanth *et al.* (2012) and Manjeshwar *et al.*(2011) in jackfruit pulp. The variation in mineral composition could be due to varietal differences and environmental conditions.

4. Conclusion

Jackfruit being an important nutritious underutilized fruit, its productivity is relatively high (25.71 tones/ha), however it is not used by many due to wide variations in pulp characteristics and taste. Most of the people prefer orange and red color pulp compared to yellow and cream color pulp, this could be a color preference of the consumers. Interestingly these types are found to contain higher concentration of carotenoids and minerals. Hence they can be promoted as desirable jackfruit genotypes for further multiplication and commercial cultivation. The fruits from such genotypes can be used to develop nutritious health drinks which are rich in natural minerals and pro vitamin A content as the product of fruit is huge and easily available in most of the South Indian states.

5. Acknowledgement

This work has been supported by DBT-New Delhi under DBT-HUB projects. The authors acknowledge the DBT-New Delhi for providing financial assistance and University of Agricultural Sciences Bangalore for providing infrastructure support for carrying out the research work.

References

[1] Alagiapillai, O.A., Kuttalam, P.S., Subramanian, V., and Jayasekhar, M .1996. PPI-I Jack: A new high yielding, regular bearing jack variety for Tamil Nadu. *Madras Agricultural Journal*, **83(5),** 310-312.

[2] Almela, L., Lopez-Roca, J.M., Candela, M.E and Alcazar, M. 1991. Carotenoids composition of new cultivars of red pepper for paprika. *J. Agric. Food Chem*.,**39**, 1606-1609.

[3] Chandrika, U.G., Janz. E.R and Waranauriya. N.D. 2005. Analysis of carotenoids in ripe jackfruit (*Artocarpus heterophyllus*) kernel and study of their bioconversion in rats. *J Sci. Food Agric.,* **85,**186-190.

[4] Conn, P.F., Lambert C, Land, Schalch, E.J, and Truscott. T.G. 1992. Free Radical. *Res. Commun.* **16**, 401-408.

[5] Erdman. J. W. Jr., Poot, C.L., and Dietz, J. M. 1998. Factors affecting the bioavailability of vitamin A, carotenoids and vitamin E. *Food Tech.* 42,214-219.

[6] Gerster, H. 1997.The potential role of Lycopene for human health. *J. Am. Coll .Nutr.*) **16**,109-126.

[7] Jagadeesh, S.L., Reddy, B. S., Swamy, G. S. K., Gorbal K., Hegde, L., and Raghavan, G. S. V. 2007. Chemical composition of jackfruit (*Artocarpus heterophyllus* Lam.) selections of Western Ghats of India. *Food Chem.,***102**,361-365.

[8] Krinsky, N. I .1993. *Annu. Rev. Nut*., **13**, 561-587.

[9] Krinsky, N. I., Landrum, J. T. and Bone.Ra. 2003. Biologic mechanism of the protective role of lutein and zeaxanthin in the eye. *Annu. Rev. Nutr.,***23**,171-201.

[10] Manjeshwar Shrinath Baliga, Arnadi Ramachandrayya Shivashankara, Raghavendra Haniadka, Jerome Dsouz, and Harshith P. Bhat. 2011. Photochemistry, nutritional and pharmacological properties of *Artocarpus heterophyllus Lam* (jackfruit): A review.

[11] Marisa M. Wall.2006. Ascorbic acid, Vitamin A, and mineral composition of banana (Musa sp.) and papaya (Carica papaya) cultivars grown in Hawaii

[12] Mclaren D, S. and Frigg, M. 2001. *Sight and Life Guide book on Vitamin A in health and diseases.* 2nd edition.

[13] Micheline M., Mathews-Roth, Madhu, A., Pathak, M. B., Thomas B., Fitzpatric, Leonard, C., Harber, and Edward H. Kass.1974. Beta-Carotene as a Photo protective agent in Erythropoietin Protoporphyria. *N. Eng J Med.,* **282,** 1231-1234.

[14] Mitra, S.K. 1999. Jackfruit: Tropical Horticulture Vol-I, Pp 359-362.

[15] Mozafer. 1994. Plant vitamins: Agronomic, Physiological and Nutritional aspects. CRC Press, Boca Raton, FL

[16] Miller, N. J., Julia Sampson, Luis P.Candeias, Peter M.Bramley And Catherine A.Rice-Evans.1996. Antioxidant activities of carotenes and xanthophylls. *FEBS Letters* 384, 240-242.

[17] Packer, J. E., Mahood, J. S., Mora-Arellano, V.O., Slater, T.F., Wilson, R. L., and Wolfenden, R.S. 1981. *Biochem. Biophys. Res. Commun*. **98**, 901-906

[18] Palozza P and Krinsky N I. 1992. Astaxanthin and canthaxanthin are potent antioxidants in a membrane model. Arch Biochem Biophys. Sep;297(2):291-5.

[19] Schweigert, C. 2001. Changes in the concentration of carotenoids, vitamin A, alpha- tocopherol and total lipids in human milk throughout early lactation. *Ann, Nutri, Met.,* **45**, 82-85.

[20] Shewfelt. R.L. 1990. Sources of variation in the nutrient content of agricultural commodities from the farm to the consumer, *Journal of Food Quality*, 13, Pp 37-54.

[21] Shrikant Baslingappa Swami, N. J. Thakor, P. M. Haldankar, and S. B. Kalse. 2012. Jackfruit and Its Many Functional Components as Related to Human Health: A Review

[22] Speek, A.J., Speek-Saichua, S., And Schreurs, W.H.P. 1988. Total carotenoids and β-carotene contents of Thai vegetables and the effect of processing. *Food Chem*. 27, 245-257.

[23] Tang, Y.P., Linda, B.L.L and Fran, L.W. 2013. Proximate analysis of *Artocarpus odoratissimus* (Tarap) in Brunei Darussalam, International Food Research Journal 20 (1):409-415

[24] Umesh, B., Jagtap. Shrimant, N., Panaskar and Bapat, V. A. 2010. Evaluation of Antioxidant Capacity and Phenol Content in Jackfruit (*Artocarpus heterophyllus* Lam.) Fruit Pulp. *Plant Foods Hum. Nutr.,* **65**, 99–104.

Table 1: Morphological characteristics of flakes from different Jackfruit genotypes

Sl.No.	Genotypes	TSS (^{0}Brix)	Flake color	Flake thickness
1.	VRT-11	25.50	Cream	Thick
2.	BHT-2	30.50	Cream	Medium
3.	KT-3	29.50	Cream	Thick
4.	BHT-3	28.50	Light Yellow	Thick
5.	BHT-5	20.00	Light Yellow	Thick
6.	KT-7	26.50	Light Yellow	Medium
7.	KT-10	22.50	Dark Yellow	Thin
8.	APT-14	25.00	Dark Yellow	Thick
9.	SWARNA	21.50	Dark Yellow	Thick
10.	TDT-11	32.00	Orange	Medium
11.	BHT-7	26.00	Orange	Thick
12.	BHT-8	26.00	Orange	Thick
13.	NKT-2	23.00	Red	Medium
14.	NKT-3	30.00	Red	Medium
15.	ALG-16	23.00	Red	Medium

Sample collection places.
BHT- Bommarasanahalli,- Tumkur district
VRT- Virupakshipura,-Tumkur district
KT-Kachahalli, - Bangalore Rural District
NKT-Nelukunte- Bangalore Rural District
APT- Ankapura, Tumkur district
TDT- Thirumaladevarathi, Tumkur district
ALG-Allalgatta Tumkur district

Table 2: Estimation of carotenoids in different Jackfruit pulp colours by Spectrophotometric method

PULP COLOR	α-carotene (µg/100g)	β carotene (µg/100g)	β crypto xanthine (µg/100g)	Lycopene (µg/100g)	Total carotenoids (µg/100g)
Cream	0.02524	0.02201	0.02045	0.01268	0.08068
Light yellow	0.06137	0.09125	0.0525	0.06017	0.26529
Dark yellow	0.2511	0.2755	0.2367	0.1942	0.9575
Orange	0.9665	1.2228	1.0622	0.5877	3.8392
Red	0.934	1.294	1.0914	0.7368	4.0562
Mean	0.0667	0.2229	0.9074	0.9601	2.5171
SEM	0.0153	0.0371	0.1459	0.0408	0.2391
CD	0.0727	0.1760	0.6925	0.1937	1.1349

Table 3: Mineral content in different pulp colours of Jackfruit (mg/100g pulp)

Sl. No.	Pulp color	Potassium	Sodium	Manganese	Zinc	Iron	Copper
1.	Cream	196.86	1.82	0.0354	0.1174	0.374	0.1214
2.	Light yellow	212.87	1.51	0.0428	0.0907	0.2884	0.1027
3.	Dark yellow	326.47	2.74	0.124	0.197	0.322	0.24
4.	Orange	216.07	2.16	0.0608	0.120	0.864	0.163
5.	Red	322.7	2.84	0.0610	0.164	1.044	0.2524
Mean	-	254.9867	2.2133	0.0654	0.1378	0.5783	0.1759
SEM	-	8.0371	0.2050	0.0067	0.0088	0.0389	0.0136
CD	-	27.3239	0.6460	0.0211	0.0277	0.1226	0.0429