ISSN: 3065-0437

Columbia Journal of Engineering and Technology

Research Article

JACKFRUIT PARTS AS NUTRITIONAL POWERHOUSES: EVALUATING MINERAL, ANTIOXIDANT, AND ANTINUTRITIONAL PROPERTIES IN AKWA IBOM STATE, NIGERIA

Eno Imaobong Akpan

Department of Chemical Sciences & Science Technology, Akwa Ibom State Polytechnic, Ikot Osurua, P.M.B. 1200, Ikot Ekpene, Nigeria.

DOI: 10.5281/zenodo.14638857

Abstract

Jackfruit is the world largest tree borne fruit, usually cultivated for its high yield and its sweet and highly flavored taste. It is made up of several parts (peal, bulb, core and seed etc), of which only the edible bulb is underutilized while the other parts are unutilized and assumed waste in this part of the world. This study therefore aimed at evaluating the essential minerals, antioxidants and antinutritional components of these parts separately using acceptable methods. The plant used for the study was that cultivated here in Akwa Ibom and at the edible ripe stage. The result showed that all parts of the fruits contain all the analyzed chemicals revealing that the highest levels of Ca(23.4 ± 0.29), Phosphorus (P) (0.09 ± 0.01), Cobolt (Co) (0.94 ± 0.01) and Iron (Fe) (29.21 ± 1.30) were in the skin, and the least of these elements Ca(13.5 ± 1.5), P (0.01 ± 0.00), Co (0.15 ± 0.01) and Fe (0.96 ± 0.02) were found in the edible bulb. Highest concentrations of Sodium Na (12.21 ± 3.07), Potassium K (4.18 ± 0.35) and Magnesium Mg (6.03 ± 1.35) were recorded in the seed and their least values Na (6.02 ± 0.02), K (0.88 ± 0.06) and Mg (2.41 ± 0.48) were recorded in the edible bulb, rag and skin respectively. Finally, Manganese (Mn), Zinc (Zn) and Copper (Cu) had their highest values (0.71 ± 0.00, 0.52 ± 0.00 and 0.44 ± 0.00) respectively recorded in the edible bulb and their lowest values all recorded in the rag. All the parts analyzed exhibited quite appreciable level of vitamins A, C and E. The antinutrient levels are not significant. Thus, attention be given to the cultivation processing, distribution and effective utilization of the fruits. .

Keywords: Essential Minerals, Antioxidant, Antinutrients, Jackfruit parts

INTRODUCTION

The continuous and rapid growth of the world population has a great impact on food demand and thus poses a great challenge to obligatory food researcher, producers and manufacturers, thus forcing these sectors to maximize the utilization of the existing food or plant resources (Akter and Haque 2019). In the course of processing raw agricultural product to finished food product, enormous waste products are obtained. According to Balasundram *et al* (2006), some of the waste may end up as animal feed while others return to the soil as organic nutrients rich in carbohydrates, proteins, Mineral and vitamins depending on sources. These waste, they suggested could be in the form of peels, seed, whey, waste liquid, molasses, baggage and so on.

The disposal of parts of fruits, vegetables and other plants is a key environmental concern as they result in increased bio-waste accumulation that is considered a breeding ground for food-borne and water-borne pathogens (Feumba *et al*, 2016). Asquieri *et al* (2008) reported that the main sources of biowaste are factories such as the fruit juice processing plants in the food industry that have huge accumulation of unutilized parts of the fruit. Thus, there is need to recycle unutilized parts of such fruits to prevent their bioaccumulation (Adom *et al*, 2020; Aktar and Haque, 2019). Jackfruit happen to be one of such fruit with enormous utilized parts which make up above 70% of the fruit of total fruit weight (Borgis and Bharati, 2000).

Jackfruit (*Artocarpus heterophyllus lam*) belong to the moraceae family, native of India and seen abundantly in Western Ghats, a biodiversity spot of India (Jagadesh *et al*, 2007). It is also common in Ski-Lankea and Bangladesh where it is known as poor man's food because it is cheap and plentiful during season. It is found in Burma, Phillipine, Indonesia, Thailand, Malaysia and Brazil (Prakash, 2009; Baliga *et al*, 2011).

The plant has slowly gain its way into Africa and the news of its sweet taste and rosy/vanilla flavour is seriously gaining popularity, thus, many people have started planting it for the delicacy of it edible bulb and high fruit yield while the other parts which make up about 70% of the fruits total weight are unutilized and are discarded as waste in the form of skin, central axis (Core), seed and Perianth (rag) which has been reported to have high utilization in different foods and chemical industries as reviewed by Akter and Haque (2019). However, even the edible bulb is still not accepted by many in the Nigerian context. Therefore, considering its high yielding of 20 – over 200 fruits per tree as reviewed by Renasinghe *et al*., (2019), Its availability therefore will be a source of enormous waste that will be disposed to the surrounding. Thus, this research is justified to establish some economic values for these different parts of the fruit based on it minerals, vitamins and antinutrient composition.

According to Borgis and Bharati (2020), nutrition plays an important role in maintaining good health. Micro nutrients like vitamins and minerals are protective nutrients essential in growth development and maintaining good health. While Anti-oxidants are non-nutritive substances that prevent oxidative damage by free radicals and reactive oxygen species.

MATERIALS AND METHODS Sample Collection and Preparation

Matured but yet to ripe jackfruit was procured from fruit vendors in Otor Market at Ikot Ekpene, Akwa Ibom State of Nigeria. The fruit was kept in a cool corner of the laboratory for about 3 days until ripened and soft. The fruit was then washed with clean water, cut into smaller sizes and then separated into four parts; the edible bulb, the skin, the rag and the seed.

The different parts were chopped separately into tiny sizes and dried in a hot air oven at about 50^{O}C and weighing intermittently until constant weight was obtained. These samples were then ground to powdered form using mortar and pestle and then stored in air tight container for the different analysis.

Mineral Analysis

The samples were digested by wet digestion method using a 1:2 combination of Nitric acid to Hydrochloric acid until the solution becomes clear. The elements calcium (Ca), magnesium (Mg) and others were determined using Atomic Absorption Spectrophotometer. Sodium (Na) and Potassium (K) were determined using flame. Photometer phosphorus (P) was estimated using venado-molybdenum (yellow) method as described by AOAC (2002). All determinations were done in triplicate.

Vitamin Analysis

Vitamin A was determined in all the samples using colorimetic method (James, 1984). 1g of ground sample was taken into a beaker, 10mls of Chloroform was added to extract the Vitamin A. Using Pasture, the chloroform layer was pipetted into another test tube and was tested with antimony dichloride reagent to develop a blue colour read at 620nm against chloroform/$SbCl_3$.

Vitamin C: This was determined as described by Pearson (1976). 10g of the sample was extracted with 50ml EDTA extracting the solution for one hour and filtered through paper into a 50ml volumetric flask and made up to the mark with the extracting solution (EDTA), 20ml of the extract was pipetted into a 250ml conical flask and 3 drops of 1% starch indicators was added and titrated with 0.01m $CaSO_4$.

$$\% \text{ Vitamin C} = \frac{\text{Concentration of titrate x titre value x 100}}{\text{Volume of Sample}}$$

Vitamin E: 0.5g of the different samples were measured into a centrifuged tube with a tight stopper. 0.5ml of anhydrous ethanol was added and shaken vigorously for another 1 minute. The sample was certified at 1,500 x g for 10 minutes; simultaneously, 0.25ml of bathrophenonthroline solution was added to the sample and then centrifuged. 1.5ml of the supernatant was collected with micropette and transferred into a cuvette. 0.25ml of Ferric chloride solution was added and mixed thoroughly. The sample was taken for spectrophotometric measurement. The standard was prepared using 0.5m of trolox and the text sample was also prepared using alpha-tocopherol.

The absorbance of sample (Ax) and Absorbance of Standard (As) were measured at 539nm against blank and the concentration test of Vitamin E (um) in the analyzed sample was calculated as follows:

$$Cx = \frac{Ax \times Cs}{As}$$

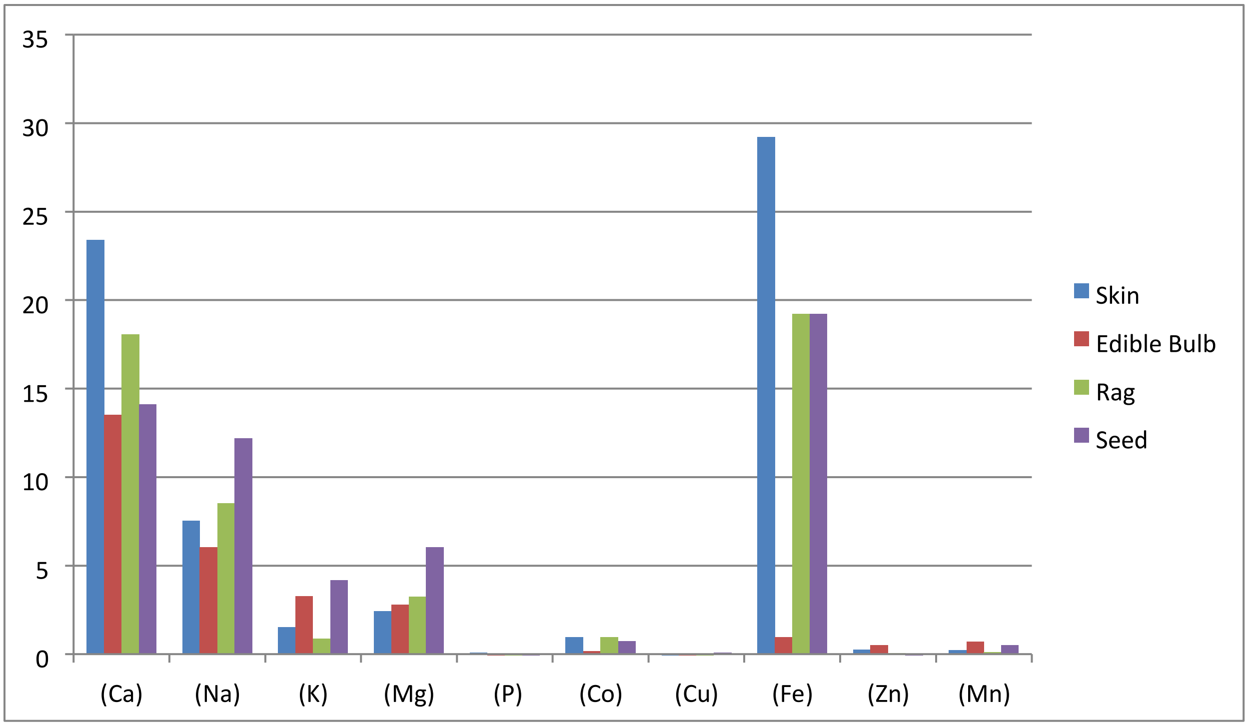
Where Cx = Concentration of Sample
Ax = Absorbance of test sample
As = Absorbance of standard
Cs = Concentration of Standard

Antinutrients: These processes were as described by Oke (2005), where Tannins, Hydrogen cyanide HCN and phytate were extracted by water acid as required and extract processed and respective absorbance taken at different wavelength. However, oxalate determination involves three major steps. The digestion, the oxalate precipitation and permanganate titration.

RESULTS: The results of the minerals and vitamins of the four parts of jackfruit are presented in Table 1, 2 and 3 below:

Table 1: Results of Minerals in mg/100g.

Minerals	Skin	Edible bulb	Rag	Seed	RDA/AI/Mg /day M/F(US)mg
Calcium (Ca)	23.41 ± 0.29	13.51 ± 1.5	18.06 ± 1.48	14.10 ± 0.13	1,000
Sodium (Na)	7.53 ± 0.51	6.02 ± 0.02	8.52 ± 0.71	12.21 ± 3.07	1,500
Potassium (K)	1.53 ± 0.08	3.28 ± 0.29	0.88 ± 0.06	4.18 ± 0.35	4,700
Magnesium (Mg)	2.41 ± 0.48	2.79 ± 0.83	3.24 ± 0.13	6.03 ± 1.35	420/320
Phosphorus (P)	0.09 ± 0.01	0.01 ± 0.00	0.01 ± 0.41	0.02 ± 0.00	700
Cobolt (Co)	0.94 ± 0.01	0.15 ± 0.01	0.94 ± 0.01	0.73 ± 0.05	None
Copper (Cu)	0.04 ± 0.00	0.44 ± 0.00	0.03 ± 0.00	0.09 ± 0.00	0.9
Iron (Fe)	29.21 ± 1.30	0.96 ± 0.02	19.21 ± 1.30	19.22 ± 0.13	8/18
Zinc (Zn)	0.26 ± 0.00	0.52 ± 0.00	0.07 ± 0.01	0.017 ± 0.08	11/8
Manganese (Mn)	0.23 ± 0.00	0.71 ± 0.00	0.11 ± 0.02	0.52 ± 0.00	23/1.8



Values are given in Mean of triplicate values ± standard deviation.

RDA = Recommended Dietary Allowance. AI = Adequate Intake.

Table 2: Results of Vitamins A, C and E in mg/100g (Antioxidants) in the different parts of Jackfruit.

Vitamins	Skin	Bulb	Rag	Seed	RDA Male/Female Mg/100g
A	3.12 ± 0.01	3.50 ± 0.00	9.15 ± 0.01	-	900/700
C	5.93 ± 0.04	5.54 ± 0.02	5.11 ± 0.01	-	90/75
E	4.13 ± 0.01	6.38 ± 0.02	3.99 ± 0.01	-	15

'Value' = Mean ± Standard deviation of Triplicate determinations. '-' = No analyzed.

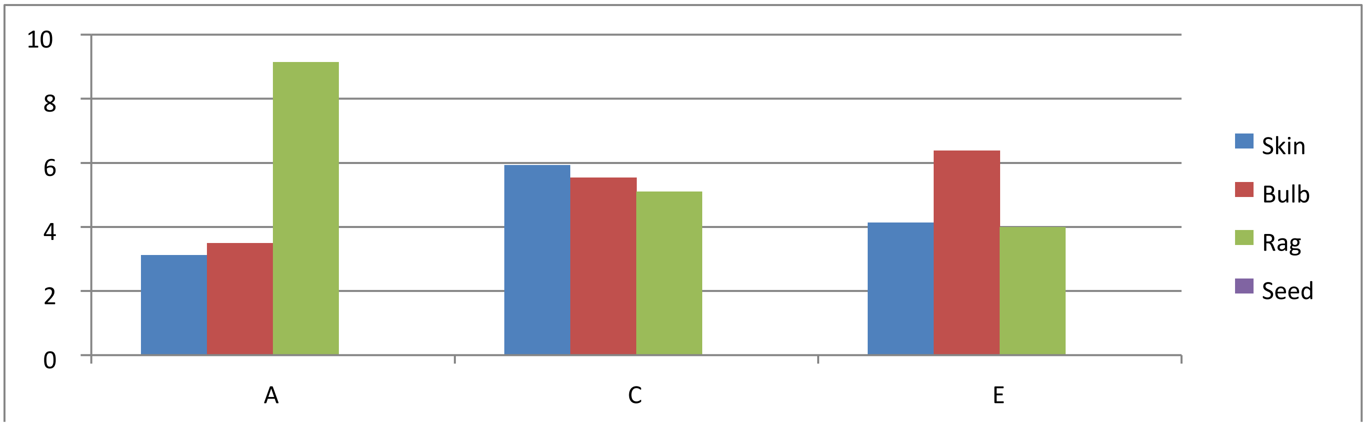
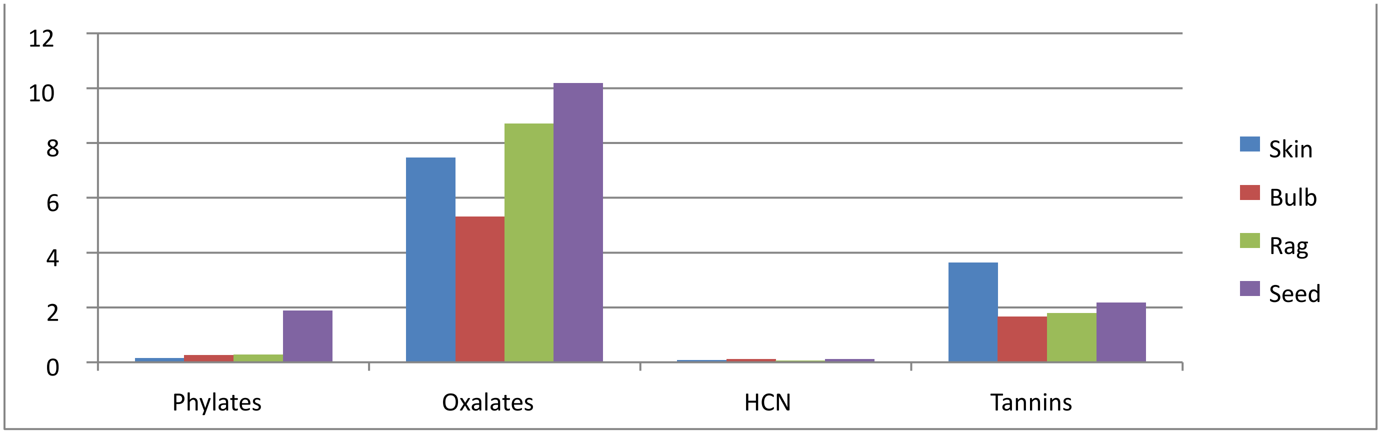


Table 3: Results of Antinutrients in mg/100g for different parts of jack fruit.

Antinutrient	Skin	Bulb	Rag	Seed
Phytates	0.153 ± 0.014	0.259 ± 0.002	0.291 ± 0.003	1.889 ± 0.002
Oxalates	7.46 ± 0.028	5.318 ± 0.132	8.705 ± 0.134	10.195 ± 0.051
HCN	0.085 ± 0.004	0.107 ± 0.002	0.067 ± 0.002	0.115 ± 0.003
Tannins	3.637 ± 0.006	1.676 ± 0.022	1.786 ± 0.070	2.184 ± 0.079

Values = M ± Standard deviation of triplicate determination.



Discussion: From the results presented in Tables 1, 2 and 3 above, all the investigated parts of the fruit contain all the chemicals in different concentration and in the following increasing order.

The skin exhibits the highest concentration of Ca, P, Co and Fe, and the bulb the least. Highest values of Na, K and Mg were recorded in the seed while their least values were found in bulb. Cu, Zn and Mn were the highest in the edible bulb and lowest in the rag.

The range of Ca values obtained here for all the samples are lower than the range (26.9 – 33.8) mg/100g recorded for edible fruit flesh at different ages in days from (30.0 – 73.2)mg/100g recorded for young fruit but in accordance with (20.0 – 37.0)mg/100g recorded for ripe fruits as reviewed by Renasinghe *et al*, (2019). Also, these values are lower than 234. 24 ± 0.02 for jack fruit seed flour (Borgis and Bharati, 2020) also lower than the values (4.9 ± 1.31, 7.32 ± 0.99 and 6.94 ± 2.074) mg/g recorded for extract from peels, fiber and core respectively. (Adam *et al*, 2020).

All the ranges of values obtained in this research for P, Mg, Cu, Zn and Mn are lower than P (105.93 ± 0.03), Mg (162.57 ± 0.02), Cu (4.25 ± 0.03), Zn (2.03 ± 0.02) and Mn (2.02 ± 0.03) recorded for jack fruits seed flower (Borgis and Bharati, 2020). They are also lower than the values recorded by Adan, et al. (2020) for peels, fiber and core. Iron (Fe) values of the skin, rag and seed of this research sample were higher than Fe values (0.112 ± 0.06, 0.088 ± 0.133 and 0.051 ± 0.023) mg/g recorded for peels, fiber and core respectively (Adan *et al,* 2020), higher than (0.4 – 19) and (2.0 – 41.0) for young and ripe fruits respectively as reviewed by Resinghe *et al*, (2019) and also higher than 12.55 ± 0.03 mg/100g reported by Borgis and Bharati (2020) for the seed flour. These values were on the other hand lower than the values of the same minerals obtained by Mahmood et al (2012) for fully ripened strawberries and cherry. The diversities in these values can be associated with the fruit varieties, geographical location of cultivation, preparation techniques and analytical error. Calcium, phosphorus and Magnesium are essential for carbohydrate metabolism, bone and teeth formation, enzyme activities and the regulation of acid-alkaline balance in the body (Scarlbet 1991 and Brody 1994). Iron is essential for blood formation (Kittiphoom, 2012). Cu is involved in Iron metabolism. Manganese is a co-factor in several enzymes whereas Zinc is an essential part in more than 100 enzymes involved in energy metabolism (Huskisson et al, 2007) as reported by Adan et al (2020).

Vitamins: Results of Vitamin A revealed edible bulb: (3.50 ± 0.00) > skin (3.12 ± 0.10) > Rag (2.15 ± 0.01). Vitamin C showed Skin (5.93 ± 0.04) > bulb (5.54 ± 0.02) > Rag (5.11 ± 0.01) and Vitamin E revealed bulb (6.38 ± 0.02) > Skin (4.13 ± 0.01) > Rag (3.99 ± 0.01). These values are quite low when compared with the RDAs of these Vitamins except for Vitamin E which are quite appreciable especially in the bulb. This is in line with the study of Adan *et al* (2020) who reported remarkable antioxidants and antimicrobial activities from peel, fiber and core of jack fruit. These research values of Vitamins A and C are higher than the roots of values, Vitamin A (0.4 – 1.9 and 0.5 – 11) and C (0.05 – 0.2 an d 0.05 – 0.4) reviewed by Renasinghe *et al* (2019) for young fruit and ripe fruit respectively. However, the values of Vitamin A (iu), 30 and Vitamin C (12.0 – 14.0) for young fruits and

Vitamin A, 17.5 – 54.0 and Vitamin C (7.0 – 18.0) for ripe fruits reviewed by Renasinghe are much higher than the result obtained in this research. However, the Vitamin C obtained here were lower than the range 18.5 – 24.03 mg/100g for jack fruit flesh at different ages in days and also lower than the 10mg/day required for adults and necessary to prevent overt symptoms of scurvy. The amount beyond which the bulk vitamin C is not retained in the body but rather is excreted as such in the urine as 200mg/day (NRC 1989). In addition, while Vitamin E in this study are higher than those recorded for most of the top 15 vitamin E foods (Link, 2022). Peanut 1.91-ounce, Mango 1.8mg, Tomatoes 1.3mg, Sunflower seed 58%, Almond 7.3mg and Hazel nuts 4.2mg/ounce. Given that the Vitamin E requirements are 0 – 6 months – 4mg/day, 7 – 12mg/day, 1 – 3yrs, 6mg/day, 4 – 8 yrs, 7mg/day, 9 – 13years (11mg/day), 14+ years (15mg/day).

The antinutrient values of this study were all below their lethal doses and are in accordance with the results reported by Amadi et al (2018) for pulp, leaves and seeds. Oxalate, phytates and HCN were highest in the seed while Tannins was highest in the skin and least in the bulb and HCn least in the Rag.

Conclusion:

From this research, it is evidenced that the underutilized and unutilized parts of jack fruits are good, natural sources of minerals and vitamins with little or no antinutrient to inhibit nutrient intake. This can be used to establish their role in some important biological activity when consumed. Thus, their importance in the food, pharmaceutical and animal feed production industries could be considered and its cultivation encouraged.

References

Adan, A. A; Ojwang, R. A., Muge, E. K., Mwanja, B. K. and Nyabaga, E. N. (2020). Phytochemical composition and essential mineral profile, antioxidant and antimicrobial potential of unutilized parts of jackfruit. *Food Research* 4(4):1125 – 1134.

Akter, F & Haque, M. A (2019). Jack fruit waste: A promising source of food and Feed. *Bangladesh Journal online e-research gate,* 23(1):91-102.

AOAC (2000). Association of Official Analytical Change. 20th Edition. Washington D. C.

Asquieri, E. R. Rebelu, A.M.S., and Silva, A. G. M. (2008). Fermented Jackfruit: Studies on its physciochemical and sensorial characteristics. *Food science and Technology* 28:881-887.

Balasundram, N., Sundram, K and Samman, S. (2006). Phenotic Compounds in Plants agricindustrial by-products. Antioxidants activity, occurrence and potential uses. *Food Chemistry* 99:191-203.

Balya, M. S., Shivoshankara, A. R., Haniadka, R., Disourgen, J. and Bhat, H. P., (2011). Phytochemistry, Nutritional and Pharmacological properties of Artocerpus Leterophyllus Lam. (Jackfruit): *A review "Food Research International"* 44(9):18001811.

Borgis, S and Bhatti, P. (2020). Mineral composition and Antioxidant Profile of Jackfruit (*artocarpus heterophyllus lam*.) Seed Flour. *EPR International Journal of Research and Development (IJRD).* 5(11):159-162.

Brody, T. (1994). Nutritional Biochemistry. New York USA: Academic Press. Pp450 – 459.

Feumba, D. R., Ashqini, R. P and Ragu, S. M. (2016). Chemical composition of some selected fruit peels. *European Journal of Food science and Technology* 4(4):12-21.

Huskisson, E., Maggani, S and Ruf, M. (2007). The role of Vitamins and Minerals in energy metabolism and well-being. *Journal of Introductory Medical Research*. 35:277-289.

Jagedesh, S. I. Reddy, B. S. Swamy, G. S. K. Gorbal, I. C., Hedge, I and Ragbavan G. S. U., (2007). Chemical Composition of Jackfruit (Artocorpus heterophyllus lam) Selection of Western charts of India. *Food Chemistry,* 102 (1):361-365.

James, C. S. (1984). Analytical chemistry of foods. London, U.K: Blackie Academic and Professional.

Kittiphom, S. (2012). Utilization of Mango seed. *Introduction Food Research Journal,* 19(4):1325 - 1335.

Link R. (2022). Top 15 Vitamin E foods and their benefits. Dr. Axe – Cofounder of Ancient Nutrition. Vit E foods. https://draxe.comsnutrition>vitamins.Accessed20/03/2023. Time: 2.35pm

Mahmood, T; Anwa, F; Iqbal, T; Bhatti, A. I. and Ashraf M (2012). Mineral composition of Strawberry, Mulberry and Cherry fruit at different ripening stages as analyzed by inductively coupled plasma – optical emission spectroscopy. *Journal of Plant Nutrition,* 35:111-122.

National Research Council (NRC) (1989) Recommended Dietary Allowances. 10th edition, Chapter 8, Washington D.C. The National Academics Press pp117 https://doiorg/10.17226/1349.

Prakash, O; Kumar, R; Mishra, A and Gupta, R. (2009). Artocarpus Leterophyllus (Jackfruit): *An overview PHCOG Rev*. 3(6):353-358

Ranasinghe, R.A.S.N., Maduwanthi, S.D.T and Marapana, R.A.U (2019). Nutritional and Health Benefits of Jackfruit (Artocarpus heterophyllus lam): A review. International *Journal of Food Science*. Vol. 2019/Article ID 4327183:1-12.

Scarlbert, A. (1991). Antimicrobial properties of tannins. *Phytochemistry*, 30:3875-3883.