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Nutrient and Phytochemical Composition of Jackfruit (*Artocarpus heterophyllus*) Pulp, Seeds and Leaves

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ABSTRACT
The study aimed to evaluate the nutrient and phytochemical composition of jackfruit pulp, seed and leaves. Jackfruit was harvested from a local farm located at Obiangwu, Ngor Okpala Local Government Area, Imo State, Nigeria. Nutrient and phytochemical compositions was evaluated using standard methods. Means and standard deviation was computed using statistical product for service solution (SPSS) version 22.0. One-way analysis of variance (ANOVA) and Turkey test was used in computing and separating the means. Statistical significance was set at P<0.05. Crude protein (10.09±0.11), fat (4.29±0.12) and carbohydrate (7.89±0.13) were significantly higher in the jackfruit seed while crude fiber (4.91±0.06) and ash (2.53±0.06) were significantly (p<0.05) higher in the jackfruit leaves. The micronutrient composition shows that jackfruit pulp was significantly (p<0.05) higher in potassium (0.33±0.01), vitamin C (2.10±0.01), zinc (9.28±0.11) while the leaves was significantly (p<0.05) higher in calcium (0.52±0.01), manganese (12.75±0.35) and iron (59.50±0.71). The phytochemical composition shows that jackfruit pulp was lowest in phytic acid, oxalate, alkaloids, tannin and flavonoid (6.14, 3.69, 7.88, 0.03, and 3.91). Jackfruit seed was higher in phytic acid (8.11±0.06) and oxalate (5.53±0.13) while the leaves was higher in alkaloid (7.88±0.06), tannin (0.06±0.01) and flavonoid (2.03±0.06). The study revealed that jackfruit pulp, seed and leaves are rich in nutrients studied. Phytochemicals in the jackfruit pulp, seed, and leaves would enhance health especially in the fight against non communicable diseases.
Keywords: jackfruit, nutrient, phytochemical

INTRODUCTION

Jackfruit (*Artocarpus heterophyllus*) belongs to Moraceae family. They grow abundantly in India, Bangladesh, in many parts of Southeast Asia and in some parts of Nigeria (1). Jackfruit is a non-leguminous plant whose seed and pulp are edible (2). Cotyledons of jackfruit are fairly rich in starch and protein (3). Jackfruit contains protein, starch, calcium, and thiamine (4). According to Ojwang *et al.* (5) jackfruit seeds contain more sodium, calcium, iron, magnesium, zinc and copper than jackfruit pulp. The seeds may be boiled, or roasted and eaten or boiled and preserved in syrup like chestnuts. Jackfruit seeds can be used in confectionaries (6). Jackfruit when ripe has a distinct flavor and is consumed as dessert and in other culinary preparations. The sycamore seeds are used in cooked dishes and its flour is used for baking. Jackfruits can also be cooked as vegetable and used in curries or salads (7). Jackfruit pulp when pureed can be used in the production of infant formulas, juice, jam, jelly, and base for cordials while various parts of jackfruit tree have been used in ethno-medicine and its wood is useful in timber industries (8).

Phytochemicals are bioactive compounds in foods which help the body to react to free radicals and oxygen species. The protective role of phytochemicals has been associated with their antioxidant activity

because of the excess production of reactive oxygen species and reactive nitrogen species (oxidants) in human population which causes an imbalance and oxidative damage to large biomolecules such as lipids, DNA, and proteins. This effect leads to the pathogenesis of some chronic diseases such as CVD, some cancers, ageing and diabetes (9, 10). Phenolic acids and flavonoids are higher in jackfruit seeds than jackfruit pulp (5).

In Nigeria, jackfruit cultivation and consumption has gone into extinction and regarded as food for the poor. There is paucity of studies on the nutritional and phytochemical composition of jackfruit seeds, leaves and pulp in Nigeria. Therefore, the study sought to evaluate the nutritional and phytochemical composition of jackfruit pulp, seed and leaves.

MATERIALS AND METHODS

Sample collection

The jackfruit fruit and leaves were harvested from a local farm located at Obiangwu in Ngor-Okpala Local Government Area, Imo State.

Sample preparation

Preparation of jackfruit leaf

Jackfruit leaves was separated from the plant using sterile knife, sliced, washed with portable water and pounded into mash using mortar and pestle. The grounded mash was packed into a sterilized plastic material for and stored in the refrigerator further laboratory evaluation.

Preparation of jackfruit pulp

The jackfruit pulp was separated from the seed using sterile knife and sliced into pieces. The sliced pulp was pounded into mash using mortar and pestle. The ground mash was packed into a sterilized plastic material and stored in the refrigerator for further laboratory evaluation

Preparation of jackfruit seeds

Jackfruit seeds was separated from the pulp manually using sterile knife and washed with running water. The seeds were allowed to dry for the removal of the seeds coat. The seeds were pounded into mash using mortar and pestle. The grounded mash was packed into a sterilized plastic material and stored in the refrigerator for further laboratory evaluation.

Nutrient and phytochemical analysis

The samples were analyzed for proximate composition (%protein, %ash, %fibre, % fat and % carbohydrate) and vitamin C using standard methods by AOAC (11). Vitamin A was determined using spectrophotometric method described by Pearson (12). Phytate (13), tannin (14) and oxalate (15) while alkaloids and flavonoid (11) were determined as specified. All analysis was done in triplicates.

Statistical method

Means and standard deviation were calculated for all the samples. One way analysis of variance (ANOVA) and turkey tests were used to separate and compare the means (16).

RESULTS

Proximate composition of jackfruit seeds, pulp and leaves

The proximate composition of jackfruit seed, pulp, and leaves are presented in Table 1. The moisture content ranged from 71.92% (seed) to 86.93% (pulp). Crude fiber ranged from 30.1% (pulp) to 10.16% (leaves). Ash content ranged between 0.89% (seed) to 2.53% (leaves). Jackfruit seed had the highest value for protein content (10.9%), fat (4.29%), and carbohydrate (7.89%). Samples were significantly ($p<0.05$) different except carbohydrate content in jackfruit pulp and seeds.

Table 1: Proximate composition of jackfruit seeds, pulp and leaves

Sample	Moisture (%)	Crude fiber (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate (%)
Jackfruit Pulp	86.93^{a}±0.0	3.01^{c}±0.05	1.02^{b}±0.04	10.06^{c}±0.04	1.49^{b}±0.04	7.74^{a}±0.18
Jackfruit Seed	71.92^{c}±0.33	3.92^{a}±0.06	0.89^{b}±0.03	10.09^{b}±0.11	4.29^{a}±0.12	7.89^{a}±0.13
Jackfruit Leaves	85.33^{b}±0.45	4.91^{c}±0.06	2.53^{a}±0.06	1.19^{b}±0.11	0.73^{c}±0.05	5.33^{b}±0.40
LSD	0.318	0.93	0.078	0.418	0.057	0.266

Values are means (±) standard deviation of duplicate analysis, mean scores with different superscript letter (a, b, c) in the same column are significantly different ($p<0.05$).

Minerals and vitamin content of jackfruit seeds pulp and leaves

The mineral and vitamin composition of jackfruit seed, pulp and leaves were presented in Table 2. Calcium content ranged from 0.03 g/100g (pulp) to 0.52 g/100g (leaves). Potassium content ranged from 0.21 g/100g (leaves) to 0.33 g/100g (pulp). Manganese content ranged from 9.50 mg/100g (seed) to 12.75 mg/100g (pulp). Iron content ranged from 18.25 mg/100g (seed) to 59.50 mg/100g (leaves). Zinc content ranged from 5.20 mg/100g (pulp) to 9.28mg/100g (seed). Vitamin C content ranged from 0.11 mg/100g (seed) to 2.11mg/100g (pulp).

Table 2: Mineral and vitamin composition of jackfruit pulp, seed, and leaves

Sample	Calcium (g/100g)	Potassium (g/100g)	Manganese (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)	Vitamin C (mg/100g)
Jackfruit Pulp	0.03^{b}±0.01	0.33^{a}±0.01	11.75^{a}±0.35	21.50^{b}±0.71	5.20^{c}±0.07	2.10^{a}±0.0
Jackfruit Seed	0.04^{b}±0.01	0.22^{b}±0.01	9.50^{b}±0.71	18.25^{b}±0.35	9.28^{a}±0.11	0.11^{b}±0.0
Jackfruit Leaves	0.52^{a}±0.01	0.21^{b}±0.01	12.75^{a}±0.35	59.50^{a}±0.71	5.73^{b}±0.04	0.99^{b}±0.0
LSD	0.007	0.007	0.50	0.612	0.076	0.001

Values are means (±) standard deviation of duplicate analysis, mean scores with different superscript letter (a, b, c) in the same column are significantly different ($p<0.05$).

Phytochemical composition of jackfruit seeds, pulp and leaves

The phytochemical composition of jackfruit seed, pulp and leaves are presented on Table 3. Phytic acid ranged from 6.14 g/100g (pulp) to 8.11g/100g (seed), oxalate content ranged from 5.53g/100g (seed) to 0.42g/100g (leaves), alkaloid content ranged from 12.43g/100g (leaves) to 8.85g/100g (seed). The highest tannin content was recorded for jackfruit leaves (0.07g/100g), while the pulp (0.03g/100g) had the lowest content. Flavonoid content jackfruit seeds and leaves was 3.91g/100g while the seed had 2.03g/100g.

Table 3: Phytochemical composition of jackfruit seeds, pulp and leaves

Sample	Phytic acid mg/100g	Oxalate mg/100g	Alkaloid mg/100g	Tannin mg/100g	Flavonoid mg/100g
Jackfruit Pulp	6.14^{c}±0.08	3.69^{b}±0.13	7.88± 0.06^{c}	0.03^{b}±0.01	3.91^{a}±0.08
Jackfruit Seed	8.11^{a}±0.06	5.53^{a}±0.06	8.85±0.08^{b}	0.06^{b}±0.01	2.03^{b}±0.06
Jackfruit Leaves	7.51^{b}±0.11	0.42^{c}±0.08	12.43±0.08^{a}	0.07^{a}±0.01	3.91^{a}±0.08
LSD	0.088	0.097	0.077	0.007	0.073

Values are means (±) standard deviation of duplicate analysis, mean scores with different superscript letter (a, b, c) in the same column are significantly different ($p<0.05$).

DISCUSSIONS

Low crude protein observed in the leaves were comparable with the ones found in fresh cocoyam leaves (17). The protein content of jackfruit seeds presented in this study was lower than that reported by Okafor *et al*. (18) who reported 15.88% protein content in jackfruit seeds. This could be as a result of variety or geographical location which includes soil type. The carbohydrate content of the leaves was similar to the values obtained in scent leaves (5.23%) as reported by Ojimelukwe *et al*. (19) though the carbohydrate content of the pulp and seeds were significantly ($p>0.05$) higher than the leaves. The fibre content of the jackfruit seed was consistent with the value of unprocessed jackfruit seed (18) and was higher than some conventional seeds like African breadfruit as reported by Ijeh*et al.,* (20) and Isichei and Achinewhu (21) who reported 2.5% for African oil bean and melon seed while almond seeds were reported to contain 3.11% fibre (22). Also, the values for jackfruit leaves agree with the result of Ojimelukwe *et al.* (19).

Fibre has some nutritional and health benefits in Human Nutrition especially in gastrointestinal tract by reducing gastric emptying time in the small intestine, enhanced bile salt and cholesterol excretion, increased faecal bulk and faecal transit time through the bowel. The result shows a low fat content in jackfruit pulp, seed, and leaves, though it was significantly higher ($p<0.05$) in the pulp and leaves. The fat content of jackfruit seed was similar to that of African breadfruit 4.23% (20). Ash is the organic residue remaining after the organic matter has been burnt off (23). The ash content of the jackfruit leaves is significantly higher than the pulp and seeds (19) but lower than the values shown in jackfruit seeds (23). However, the study agrees with Okudu (24) who reported that jackfruit seed was higher in protein, fibre, fat and carbohydrate than jackfruit pulp.

The calcium content of the jackfruit leaves was significantly higher ($p<0.05$) than the pulp and seed, though the calcium content was significantly lower compared with other fruits and leaves (19, 25, 26). However, the study is consistent with Ojwang *et al.* (5) who reported that jackfruit seeds contain more calcium than jackfruit pulp. Calcium has been implicated in its role in rickets, osteoporosis and osteomalacia, and even in most metabolic processes in the body. Potassium consumption improves blood pressure (27). However this study revealed considerable potassium contents and is consistent with Okafor *et al.* (18). The manganese content of the jackfruit pulp and leaves were higher than that of the seeds. Jackfruit pulp is consumed fresh without additional processing and it contains considerably high manganese content unlike the seeds and leaves that may contain some anti-nutrients and would require further processing that may eventually reduces the manganese content. Manganese acts as a cofactor for enzymes involved in energy production by the mitochondria. The iron content was highest in jackfruit leaves. Iron is involved in energy metabolism as an oxygen carrier in hemoglobin, and its deficiency leads to anaemia and impaired ATP synthesis. Zinc has numerous functions in the body which includes; serving as a cofactor for the enzymes involved in the metabolism of proteins, carbohydrates, fats and alcohol. Zinc content of the jackfruit seeds was higher than the jackfruit pulp and leaves. This value was higher than the Jackfruit seeds as reported by Ocloo *et al.* (23) and Jackfruit pulp (18). The vitamin C content of

the jackfruit pulp, seed, and leaves were low. According to Bari *et al*. (28) jackfruit is a good source of vitamin C and the levels may vary depending on variety and maturation. However, the poor vitamin C content in the present study could be due to the variety and locality. Vitamin C is an effective antioxidant, and its deficiency leads to scurvy.

Phytochemicals in the jackfruit pulp are significantly ($p<0.05$) lower than the values obtained in the seeds and leaves. Phytic acid is a common storage form of phosphorus in seeds and fruits (29). This agrees with the value in the jackfruit seed that indicates a higher phytic acid content of 8.11mg/100g compared to the pulp and the leaves. Phytic acid interferes with the absorption of Ca, Mg, Fe, and Zn, by forming insoluble complexes, thereby reducing their bioavailability. The tannin content of the jackfruit pulp, seed, and leaves were very low compared with oxalate and alkaloids. The presence of flavonoid in jackfruit pulp, seed and leaves is an indication of medicinal benefits due to its antioxidant properties and increased activity of the enzymes that detoxify carcinogens (30).

CONCLUSION

The study shows that jackfruit pulp is richer in most of the nutrients analyzed. The jackfruit pulp, seed, and leaves had low phytic acid, oxalates, tannin and alkaloid content and possess high flavonoid content that promote good health.

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