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Comparative Studies on the Nutrient Composition and Antioxidant Activities of the Leaf, Pulp, and Seed Extracts of Jack-Fruit Tree (*Artocarpus heterophyllus*)

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ABSTRACT

Jackfruit (*Artocarpus heterophyllus* Lam.) is cherished for its popularity as a delectable fresh treat. Beyond its culinary appeal, jackfruit leaves, seeds, and pulps hold significance for their therapeutic attributes. Standardized techniques were employed to evaluate nutrient and phytochemical compositions. Antioxidant activities were examined through the DPPH, FRAP and reducing power assays, and *in-vitro* inhibition of lipid peroxidation. Jackfruit leaves exhibited significantly higher levels of crude protein (19.25±0.62%) and carbohydrates (30.41± 0.31%), while jackfruit leaves had elevated levels of crude fiber (4.18±0.03%) and ash (4.13±0.06%). The jackfruit pulp is high in potassium (2880.82± 118.10mg/100g) and vitamin C(5.40±0.40mg/100g). Conversely, the leaves displayed significantly higher concentrations of Zinc, Calcium, Manganese, and Iron (1830.59±86.34, 141.18±3.49, 80.33±2.01 and 20.24±0.72 mg/100g respectively). Jackfruit pulp has lower quantities of phytic acid, oxalate, alkaloids, tannin, and flavonoids (0.18%, 47.25mg/100g, 0.38%, 3.06mg/TAE/100g, and 1.35mg/100g respectively). In contrast, jackfruit seeds exhibited higher levels of phytic acid (0.30±0.04%) and oxalate (94.5±19.10mg/100g), while the leaves excelled in alkaloids (0.48±0.01%), tannin (7.61±0.27mg/TAE/100g), and flavonoids (3.10±0.13mg/100g). The leaves had the highest flavonoid (3.10±0.13mg/100g), tannin (7.61±0.27mg/TAE/100g), and alkaloid (0.48±0.01%) as well as the highest antioxidant activity, as evidenced by the FRAP assay and reducing power assay. The percentage of DPPH radical scavenging activity reached an impressive 90.1%. The abundance of phytochemicals in the plant suggests their potential health benefits in combating non-communicable diseases.

Keywords: jackfruit, nutrient composition, phytochemicals, antioxidants.

INTRODUCTION

Artocarpus heterophyllus Lam, known as the jackfruit tree and referred to as the sycamore tree in Nigeria, is a member of the *Moraceae* family. This exotic tree, originally native to the rainforest zones of the Western Ghats in India (Rahman *et al*., 1999), produces the largest edible fruit on Earth, which can weigh up to 40 kg. It is a perennial fruit tree that thrives in the evergreen and deciduous forests of tropical Africa (Rahman *et al*., 1995). The seeds and pulp of jackfruit are edible, and it is classified as a non-leguminous plant (Siddappa, 1957). The pulp, primarily composed of fiber, constitutes the major edible portion of the fruit, while the seeds are rich in nutrients such as calcium, iron, sodium, copper, zinc, and magnesium, and they can be consumed raw, cooked, roasted, or fried (Ojwang *et al*., 2018). Jackfruit is recognized for its dietary significance, serving as a vital source of carbohydrates, proteins, fats, minerals, vitamins, and phytochemicals with various health benefits (Chrips*et al*., 2008). The fruit exhibits antioxidant, immune-boosting, and anti-diabetic properties, and its different parts, including the seeds, pulp, root bark, stems, and leaves, have undergone extensive study (Jagtap *et al*., 2010).

Phytochemicals, which are bioactive compounds in foods, play a protective role in helping the body combat free radicals and oxygen species. The antioxidant activity of phytochemicals is associated with their ability to counter the overproduction of reactive oxygen species and reactive nitrogen species (oxidants) in the human population, which can lead to an imbalance and oxidative damage to important biomolecules like lipids, DNA, and proteins (Amadi *et al*., 2018). Jackfruit seeds are notably rich in flavonoids and total phenolic content compared to the pulp (Ojwang *et al*., 2018).

In Nigeria, jackfruit trees are predominantly found in the South Eastern region, but their consumption rate remains low, primarily due to the misconception that it is a fruit for the common man. There is also limited awareness regarding the nutritional and phytochemical compositions of jackfruit seeds, leaves, and pulp (Amadi *et al*., 2018). Thus, this study aims to analyze the nutritional, phytochemical composition, and antioxidant activities of jackfruit pulp, seeds, and leaves.

Materials and Methods

Sample Collection:

Fruits and leaves of *Artocarpus heterophyllus* were gathered from Uga, Enugu-ukwu, and Igboukwu, all located in Anambra state, Nigeria. These samples were identified by a taxonomist in the Department of Botany at Nnamdi Azikiwe University, Awka, Nigeria.

Sample Preparation:

The leaves of *Artocarpus heterophyllus* were cleaned with deionized water and dried. Subsequently, they were ground manually and stored. The fruits were sliced into smaller pieces, and the seeds and pulp were collected. These components were then dried in an oven at 60°C, ground, and stored.

Sample Extraction:

Two hundred grams of each ground sample were soaked in 70% ethanol for 48 hours at room temperature with intermittent stirring. The mixture was filtered, and the filtrate was evaporated at 60°C using a water bath. The dried residue was reconstituted in 70% ethanol at a concentration of 10mg/ml and stored at 4°C.

1. **Proximate Composition:** Nutrient parameters, including moisture content, ash content, crude protein, crude fat, crude fiber, and total carbohydrates, were

analyzed following the AOAC (1999) methods, and total carbohydrate content was determined according to Yerima and Adamu (2011).

2. **Vitamin Content Analysis:** Analysis of vitamin parameters (vitamin A, B_1, B_2, B_3, B_6, C, E,) was conducted using methods specified by Rutkoski *et al*. (2005), Klein and Perry (1982), Kirk and Sawer (1991), Padmarajaiah *et al*. (2002), and Raeed and Azam (2008).
3. **Mineral Composition Analysis:** Minerals including calcium, copper, iron, magnesium, sodium, potassium, and zinc were analyzed using Atomic Absorption Spectrophotometry (AAS) following AOAC (2003) procedures.
4. **Phytochemical Composition Analysis:** Phytochemical parameters (phenol, flavonoid, tannin, alkaloid, saponin, oxalate, and phytate) were analyzed through colorimetry methods as described by Barros *et al*. (2007), AOAC (1990), Obadoni and Ochuko (2002), Young and Greaves (1940), Harbone (1995), and Osagie (1998).
5. ***In Vitro* Antioxidant Assay Determination:**
    - **Free Radical Scavenging Activity:** The DPPH radical scavenging activity was determined using the method of Ebrahimzadem *et al*. (2009).
    - **Reducing Power Capacity:** The reducing power was determined according to Barros *et al*. (2007), with BHA used as a standard antioxidant.
    - **Inhibition of Lipid Peroxidation:** The inhibition of lipid peroxidation was determined following the method by Barros *et al*. (2007), utilizing goat brain homogenate. BHA served as a standard antioxidant.

EC_{50}, IC_{50}, and $OD_{0.5}$: The EC_{50} and IC_{50} values were calculated from the graphs of antioxidant activity percentage against the sample concentrations. BHA was employed as a standard antioxidant.

Statistical Analysis:

Data analysis was carried out using Microsoft Excel, presenting results using charts with error bars to display analyte, enzyme, and weight levels and their corresponding standard deviations. Percentages were used to represent changes in weights.

Results

Proximate composition of jackfruit leaves, seeds, and pulp

The mean ± standard deviation of the proximate composition of *Artocarpus heterophyllus* leaf, seed, and pulp, are shown in Table 1. The Moisture content is highest in the pulp (74.40±1.00) %, followed by the leaf (56.53±3.41%), and the seed (47.15±0.50%), while the Total carbohydrates contents are 30.41±0.32, 16.74±1.53, 14.02±4.14 % for the seed, pulp, and leaf respectively. The Ash content is highest in the leaf (4.13±0.06%) followed by the seed (1.40±0.04%) and the pulp (0.63±0.04%), while the Crude protein content is highest in the leaf (19.25±0.62%), followed by the seed and the pulp (14.66±0.31, 5.91±0.31 % respectively). The Total lipid content is highest in the seed (2.78±0.03%) followed by the leaf (1.90±0.14 %) and the pulp (1.05±0.07%) while the Crude fiber content is the lowest of the proximate composition, with (3.60±0.42, 1.28±0.10, 1.8±0.03 %) for the seed, pulp, and leaf respectively.

Table 1: Proximate composition of *Artocarpus heterophyllus* leaf, seed, and pulp

Sample	Moisture (%)	Crude (%)	Fiber Ash (%)	Crude Protein (%)	Total Lipid (%)	Carbohydrate (%)
Jackfruit Leaf	56.53±341	1.8±0.03	4.13±0.06	19.25±0.62	1.90±0.14	14.02±4.14
Jackfruit Seed	47.15±0.50	3.60±0.42	1.40±0.04	14.66±0.31	2.78±0.03	30.41±0.31
Jackfruit Pulp	74.40±1.00	1.28±0.10	0.63±0.04	5.91±031	1.05±0.07	16.74±1.53

The table shows the result of the mean and standard deviation of the proximate composition of *Artocarpus heterophyllus* leaf, seed, and fruit pulp.

Vitamins composition of jackfruit leaves, seeds, and pulp

The mean ± standard deviation of the vitamin composition of *Artocarpus heterophyllus* leaf, seed, and pulp are shown in Table 2. The vitamin C content is highest in the pulp (11.90±0.04 mg/100g), followed by that of the leaf (8.12±0.16 mg/100g) and the seed (6.90±0.20 mg/100g), while the vitamin B_3 is highest in the pulp (5.90±0.35 mg/100g), followed by the leaf (5.75±0.21 mg/100g), and the seed (5.12±0.00 mg/100g). The vitamin B_6 content is highest in the pulp (5.40±0.40 mg/100g) followed by the leaf (4.40±0.08 mg/100g) and the seed (4.01±0.16 mg/100g), while the Vitamin A is 2.96±0.66, 2.54±0.44 and 1.53±0.13 mg/100g for the pulp, leaf and seed respectively. The vitamin E content is highest in the pulp (1.60±0.14 mg/100g) followed by the leaf and the seed (1.44±0.44, 0.91±0.04 mg/100g respectively) while the vitamin B_1 is 0.14±0.01, 0.13±0.01, and 0.12±0.01 mg/100g for the pulp, leaf, and seed respectively. The vitamin B_2 was the lowest of all the vitamins. The pulp content of vitamin B_2 is the highest with 0.13±0.01mg/100g followed by that of the leaf and seed with 0.12±0.00 and 0.10±0.00 mg/100g respectively.

Table 2: Vitamin composition of *Artocarpus heterophyllus* leaf, seed, and pulp

	Sample Vit A (mg/100g)	Vit. B_1 (mg/100g)	Vit B_2 (mg/100g)	Vit. B_3 (mg/100g)	Vit. B_6 (mg/100g)	Vit. C (mg/100g)	Vit E (mg/100g)
Jackfruit Leaf	2.54±0.44	0.13±0.01	0.12±0.00	5.75±0.21	4.40±0.08	8.12±0.16	1.44±0.44
Jackfruit Seed	1.53±0.13	0.12±0.01	0.10±0.00	5.12±0.00	4.01±0.16	6.90±0.20	0.91±0.04
Jackfruit Pulp	2.96±0.66	0.14±0.01	0.13±0.01	5.90±0.35	5.40±0.40	11.90±0.14	1.60±0.14

The table shows the result of the mean and standard deviation, of the Vitamin composition of *Artocarpus heterophyllus* leaf, seed, and fruit pulp.

Mineral composition of jackfruit leaves, seeds, and pulp

The mean ± standard deviation of the mineral composition of *Artocarpus heterophyllus* leaf, seed, and pulp are shown in Table 3. The Potassium content is highest in the pulp (2880±118.10)mg/100g, followed by the seed (2277.34±36.14)mg/100g, and the leaf (1830.59±86.34)mg/100g, While the sodium content is (184.38±4.32, 167.60±15.30, 146.59±62.11) mg/100g for the pulp, leaf and seed respectively. The Calcium content is highest in the seed (182.75±6.39) mg/100g, followed by the leaf (141.18±3.49) mg/100g, and the pulp (140.59±2.29) mg/100g, While the Magnesium content is (89.73±0.67, 80.33±2.01,72.83±2.10) mg/100g for the seed, leaf and pulp, respectively. The Iron content is highest in the seed (22.67±0.79) mg/100g, followed by the leaf and pulp, (20.24±0.72 and 12.92±0.87) mg/100g, respectively, While the Zinc contents are (8.33±0.82, 7.16±0.25, 3.02±0.31) mg/100g, for the leaf, seed, and pulp respectively. The copper content was the lowest of all the mineral compositions, with (2.87±0.21,

2.78±0.51, and 2.05±0.09) mg/100g, for the seed, leaf, and pulp respectively.

Table 3: Mineral composition of *Artocarpus heterophyllus* leaf, seed, and pulp

Sample	Calcium (mg/100g)	Copper (mg/100g)	Iron (mg/100g)	Magnesium (mg/100g)	Sodium (mg/100g)	Potassium (mg/100g)	Zinc (mg/100g)
Jackfruit Leaf	141.18±3.49	2.78±0.51	20.24±0.72	80.33±2.01	167.60±15.30	1830.59±86.34	8.33±0.82
Jackfruit Seed	182.75±6.39	2.86±0.79	22.67±0.79	89.73±0.67	146.59±62.11	2277.34±36.14	3.02±0.31
Jackfruit Pulp	140.59±2.29	2.05±0.09	12.92±0.87	72.83±2.10	184.38±4.32	2880.82±118.10	7.16±0.25

The table shows the result of the mean and standard deviation of the mineral analysis of *Artocarpus heterophyllus* leaf, seed, and fruit pulp.

Phytochemical composition of jackfruit leaves, seeds, and pulp

The mean ± standard deviation of the Phytochemical composition of *Artocarpus heterophyllus* leaf, pulp, and seed are shown in Table 4. The Oxalate content is highest in the seed (94.50±19.10 mg/100g) followed by the leaf (54.00±0.00mg/100g) and the pulp (47.25±9.55 mg/100g). The Phenol contents are 36.34±2.47, 30.09±1.03 and 28.49±0.00 mgGAE/100g) for the leaf, seed and pulp respectively. The Tannin is highest in the leaf (7.61±0.27 mgTAE/100g) followed by the seed (6.62±0.27 mgTAE/100g) and the pulp (3.06±0.11 mgTAE/100g) while the Flavonoids are 3.10±0.13, 1.54±0.02 and 1.35±0.02 mg/100g for the leaf, seed and pulp respectively. The Alkaloid content is highest in the leaf (0.48±0.01 %) followed by the seed (0.46±0.02%) and the pulp (0.38±0.02 %) while the Phytate contents are 0.30±0.04, 0.22±0.01 and 0.18±0.02% for the seed, leaf, and pulp respectively. The Saponin content was the lowest of all the phytochemicals with the leaf, seed and pulp with a content of 0.14±0.02, 0.11±0.01 and 0.07±0.01 %100g respectively.

Table 4: Phytochemical composition of *Artocarpus heterophyllus* leaf, seed, and pulp

Sample	Phenol (mg/TAE/100g)	Flavonoid (mg/100g)	Tannin (mg/TAE/100g)	Alkaloid (%)	Saponin (%)	Oxalate (mg/100)	Phytate (%)
Jackfruit Leaf	36.34±2.47	3.10±0.13	7.61±0.27	0.48±0.01	0.14±0.02	54.0±0.00	0.22±0.01
Jackfruit Seed	30.09±1.03	1.54±0.02	6.62±0.27	0.46±0.02	0.11±0.01	94.5±19.10	0.30±0.04
Jackfruit Pulp	28.49±0.00	1.35±0.02	3.06±0.11	0.38±0.02	0.07±0.01	47.25±9.55	0.18±0.02

The table shows the result of the mean and standard deviation, of the phytochemical composition of *Artocarpus heterophyllus* leaf, seed, and fruit pulp.

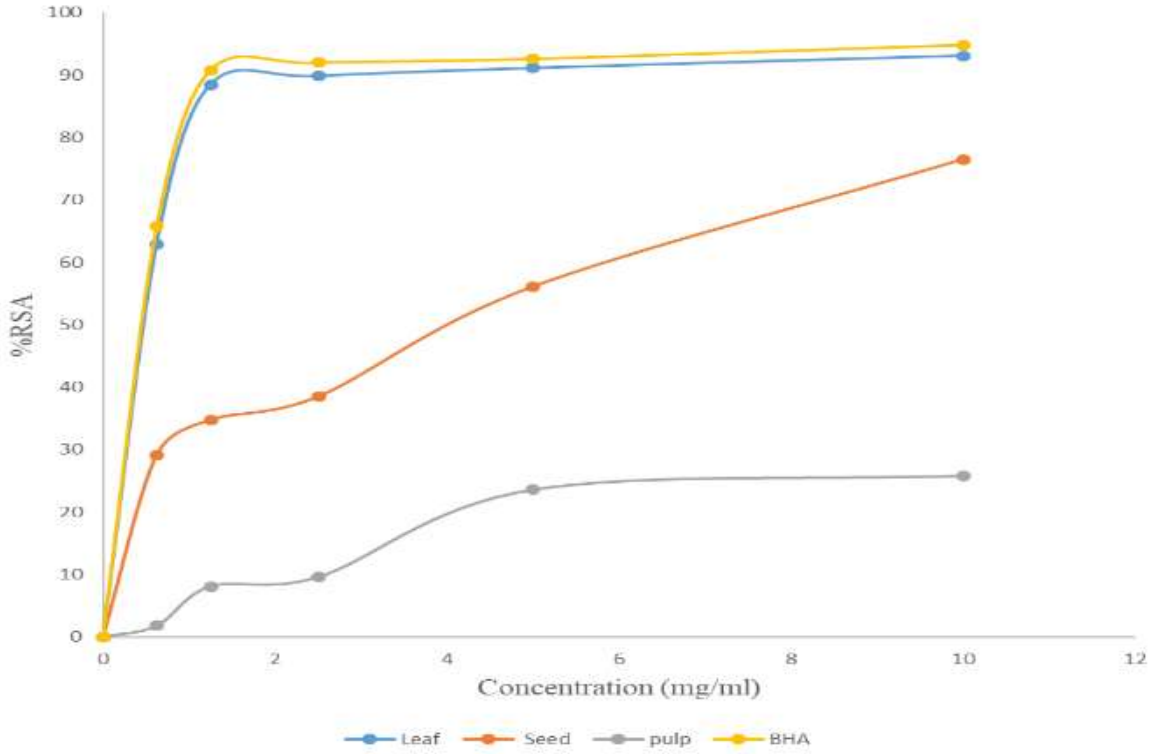


Figure 1: *In vitro* Antioxidant effect of Free Radical Scavenging Activity

Figure 1 shows the *in vitro* Antioxidant effect of Free Radical Scavenging Activity of the ethanol extract of the leaf, seed, and pulp of *Artocarpus heterophyllus* compared with that of BHA (Butylated hydroxyanisole) a standard antioxidant.

The effect of the free radical scavenging activities (DPPH) and ferric reducing absorption power (FRAP) of the extracts was highest attained in the leaf at 90.1%, while the seed and pulp at 70.2% and 20.3% respectively. BHA was attained at 92.1%, all at a concentration of 10mg/ml.

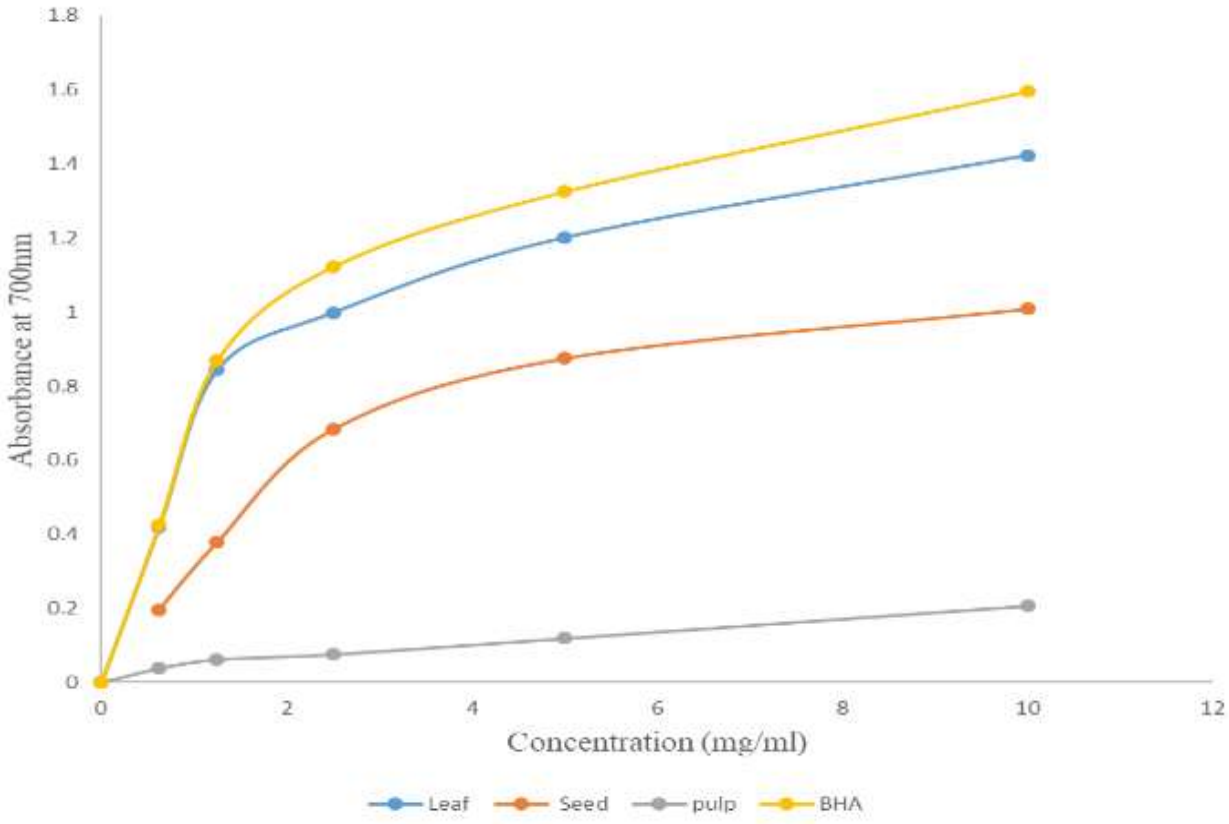


Figure 2: *In vitro* Antioxidant effect of its reducing power capacity

The graph (Figure 2) shows the *in vitro* effect of the reducing power capacity of the ethanol extract of the leaf, seed, and pulp of *Artocarpus heterophyllus* compared with that of BHA (Butylated hydroxyanisole) a standard antioxidant.

The effect of the reducing power was highest in the leaf. It was high in the seed and was least in the pulp. At absorbance 700nm, 10mg/ml concentration, the leaf attained its reducing capacity at 1.3 followed by the seed and pulp at 0.9 and 0.1 respectively, in comparison with BHA at 1.6.

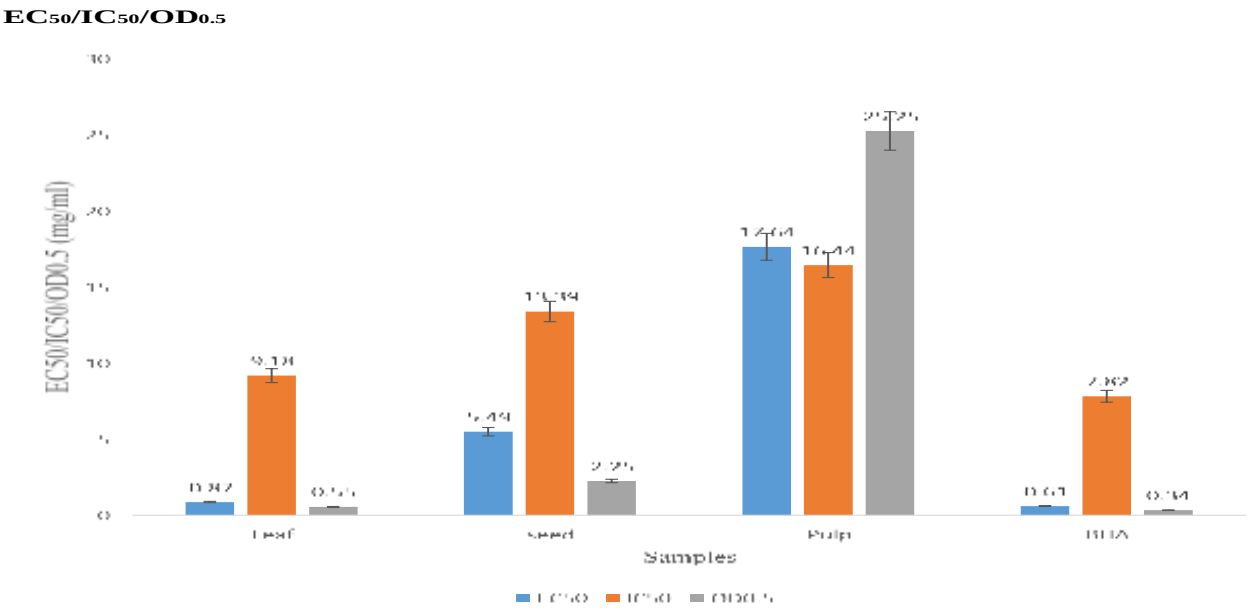


Figure 3: EC_{50}, IC_{50} and $OD_{0.5}$ of the *in vitro* antioxidant effect.

The bar chart (Figure 3) shows the EC_{50}, IC_{50} and $OD_{0.5}$ of the *in vitro* antioxidant effect of the ethanol extract of the leaf, seed and pulp of *Artocarpus heterophyllus* compared with that of BHA (Butylated hydroxylanisole) a standard antioxidant.

The lower the value of each parameter, the better the antioxidant activities. The lower EC_{50} values indicate the higher free radical scavenging ability of the leaf, seed, and pulp. The ethanol extract of the leaf has a better antioxidant activity than the seed and pulp as compared to BHA, a standard antioxidant at 0.87, 9.18, and 0.55 for EC_{50}, IC_{50} and $OD_{0.5}$, while the seed had 5.49, 13.39, and 2.25 followed by the pulp with the least activity at 17.64, 16.44 and 25.25 for EC_{50}, IC_{50}, and $OD_{0.5}$ respectively.

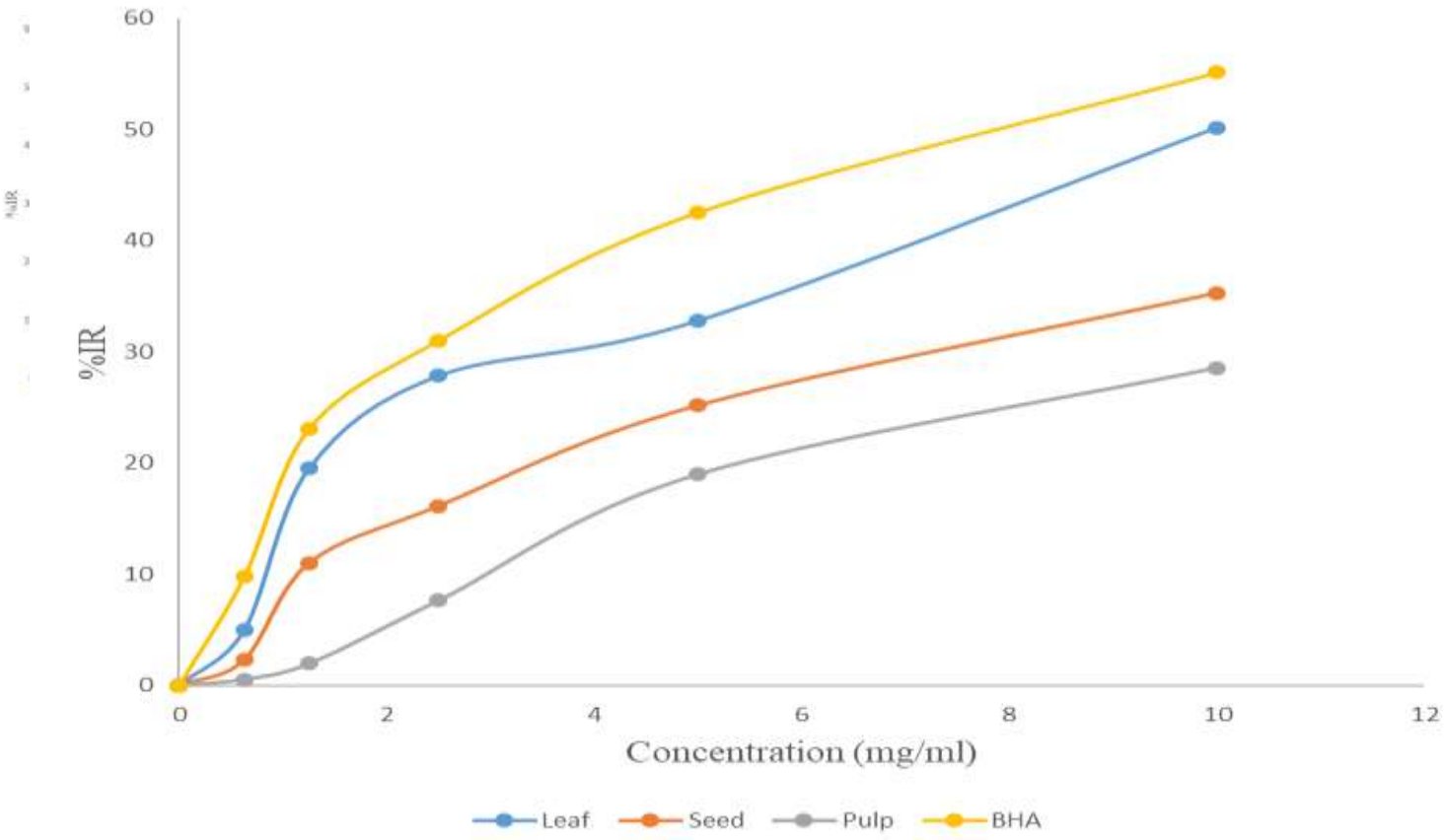


Figure 4: *In vitro* Antioxidant effect of lipid peroxidation

Figure 4 shows the *in vitro* effect of lipid peroxidation of the ethanol extract of the leaf, seed, and pulp of *Artocarpus heterophyllus* compared with that of BHA (Butylated hydroxyanisole) a standard antioxidant.

The *in-vitro* inhibition of lipid peroxidation was highest in the leaf at 49.7%, which was above that of the seed and pulp at 30.2% and 27.3% respectively at 10 mg/ml concentration.

DISCUSSIONS

This study has indicated that jack fruit tree, also known as *Artocarpus heterophyllus lam* contains nutrients, vitamins, minerals, and phytochemicals and has good antioxidant activities.

The proximate composition analysis showed that the crude protein was highest in the leaf (19.25%) and 14.66% and 5.91% for the seed and pulp respectively. Okafor *et al.*, (2015) reported 15.88% of crude protein content in jackfruit seeds, which was higher than the crude content present in the jackfruit seeds, in this research. This may be due to the variety of jackfruit or possibly geographical location or the type of soil. The Total carbohydrate contents were highest in the seed (30.41%) followed by 16.74% in the pulp and 14.02% in the leaf. The carbohydrate content of the leaves was higher when compared to the values reported by Amadi *et al.*, (2018), though the carbohydrate content of the pulp and seeds was significantly higher than that of the leaf. The

crude fiber content of the jackfruit seed was consistent, with the value of unprocessed jackfruit seed by Okafor *et al*., (2015). The fiber content was highest in the seed, followed by that of the leaf and pulp. Fiber has some nutritional and health benefits in human nutrition, especially in the gastrointestinal tract (GIT), by reducing gastric emptying time, in the small intestine, enhancing bile salt and cholesterol excretion, increasing fecal transit time through the bowel (Schakel *et al.*, 2001). The ash content of the jack fruit leaf is significantly higher than that of the pulp and seed, with values of 4.13%, 0.63%, and 1.40% respectively. The moisture content was highest in the pulp (74.40%), 56.53% in the leaf, and 47.15% in the seed. The total lipid content was highest in the seed (2.78%), 1.90% in the leaf, and 1.05% in the pulp. This research showed that the Ash and Crude protein content were highest in the leaf, the Total lipids, Crude fiber and Total carbohydrates contents were highest in the seed and finally, the moisture content was highest in the pulp.

The vitamin composition analysis showed that the overall vitamin content was highest in the pulp. The vitamin C in the pulp was highest with a value of 11.90 mg/100g, with the leaf and seed at 8.12 mg/100g and 6.90 mg/100g respectively. The vitamin B_3 in the pulp was highest at 5.90 mg/100g followed by the leaf (5.75 mg/100g) and the seed (5.12 mg/100g). The vitamin B_6 content was highest in the pulp at 5.40 mg/100g, then that of the leaf and seed at 4.40 mg/100g and 4.01 mg/100g respectively. The vitamin A content was highest in the pulp, followed by that of the leaf and seeds, with values of 2.96 mg/100g, 2.54 mg/100g, and 1.53 mg/100g. The vitamin E content was highest in the pulp, followed by that of the leaf and seed, with values of 1.60 mg/100g, 1.44 mg/100g, and 0.91 mg/100g respectively. The vitamin B_1 content was highest in the pulp, followed by that of the leaf and seed, with values of 0.14 mg/100g, 0.13 mg/100g, and 0.12 mg/100g respectively. The vitamin B_2 was highest in the pulp, followed by that of the leaf and seed, with values of 0.13 mg/100g, 0.12 mg/100g, and 0.10 mg/100g respectively. Jackfruit is a good source of vitamin C, and levels may vary depending on its variety and level of maturation. Vitamin C is a very effective antioxidant and its deficiency results in scurvy.

The mineral composition analysis showed that the calcium content of the jackfruit seed was significantly higher than that of the leaf and pulp, with values of 182.75 mg/100, 141.18 mg/100g, and 140.59 mg/100g respectively. The calcium content was significantly lower, when compared with the pulp and leaf, as reported by Ojimelukwe *et al.,* (2012). However, the study is consistent with Ojwary *et al.,* (2018), who reported that jackfruit seeds contain more calcium than jackfruit pulp. Calcium has proven its effectiveness against rickets, osteomalacia, and osteoporosis. Potassium helps to reduce and relax tension in the blood vessel walls, which helps in lowering blood pressure. Significantly, increasing potassium through diet is recommended for adults with blood pressure monitoring above 120/80 mmHg, who are otherwise healthy. The result showed that the potassium content was highest in the pulp (2880.82 mg/100g) followed by the seed (2277.34 mg/100g) and the leaf (1830.59 mg/100g). The results showed that the pulp, seed and leaves are rich in potassium as reported by Kaplan *et al.,* (1998) and Okafor *et al.,* (2015). The magnesium in the jack fruit seed and leaf was higher than the magnesium of the pulp, with values of 89.73 mg/100g, 80.33 mg/100g, and 72.83 mg/100g respectively. Jack fruit pulp is consumed fresh, without additional processing and it contains a considerable amount of magnesium, unlike the seeds and leaves, which contain a higher content, and may contain some anti-nutrients that would

require further processing. This may eventually reduce the magnesium content. Magnesium plays a role as a co-factor for enzymes necessary in energy production by mitochondria. The Iron content was highest in the jackfruit seed followed by the leaf and pulp (22.67mg/100g, 20.24mg/100g, and 12.92mg/100g respectively). Iron is known to be important, as it involves energy metabolism in which oxygen carriers in hemoglobin and its deficiency can lead to anemia. Zinc in the jack fruit leaf and pulp was higher than that of the seed with values of 8.33mg/100g, 7.16mg/100g, and 3.02 mg/100g respectively. The copper content of jack fruit seed was higher than that of the leaf and pulp with values of 2.865mg/100g, 2.78mg/100g, and 2.05mg/100g respectively. The overall mineral composition showed that the seed contains higher amounts of minerals followed by the pulp and the leaf.

The phytochemical composition in jackfruit leaf, seed, and pulp revealed noteworthy variations. Jackfruit pulp exhibited significantly lower phytochemical content compared to the leaf and seed. Specifically, the oxalate content in jackfruit seeds was notably higher than that in the leaf and pulp, with values of 94.5 mg/100g, 54.0 mg/100g, and 47.25 mg/100g, respectively. The phenol content in jackfruit leaves surpassed that in the seed and pulp, with values of 36.34 mg/GAE/100g, 30.09 mg/GAE/100g, and 28.49 mg/GAE/100g respectively. Jackfruit leaves also contained more tannins than the seed and pulp with values of 7.61 mg/TAE/100g, 6.62 mg/TAE/100g, and 3.06 mg/TAE/100g respectively. The presence of flavonoids in jackfruit leaf, seed and pulp points to potential medicinal benefits due to their antioxidant properties and their role in enhancing the activity of enzymes that detoxify carcinogens (Jagtap *et al*., 2010). Jackfruit leaves had higher flavonoid content than the seed and pulp, with values of 2.10 mg/100g, 1.54 mg/100g, and 1.35 mg/100g, respectively. Alkaloids were also more abundant in jackfruit leaves than in the seed and pulp (0.48%, 0.46%, and 0.38% respectively). Phytate content was highest in jackfruit seeds, exceeding that in the leaf and pulp, with values of 0.30%, 0.22%, and 0.18%, respectively. Phytic acid can hinder the absorption of iron (Fe), magnesium (Mg), and zinc (Zn) by forming insoluble complexes, thereby reducing their bioavailability. This is in line with values in jackfruit seeds, indicating a higher phytic acid content compared to the pulp and leaves.

The *in-vitro* antioxidant activities of jackfruit seed, leaf, and pulp, the study utilized BHA (butylated hydroxyanisole) as a standard antioxidant. Notably, the antioxidant activity and polyphenol contents in previous research on heat-treated herb leaves increased, suggesting that phenolic compounds in a partially oxidized state are more exposed to oxygen and may exhibit stronger antioxidant activity (Yi and Wetzstein, 2011; Chua *et al*., 2019a).

In the *in-vitro* free radical scavenging activity, carried out to counteract the detrimental effects of free radicals, the ethanolic extract of jackfruit leaves proved to be the most effective at 90.1% at a concentration of 10mg/ml, compared to 75.1% and 25.1% for the seed and pulp, respectively. BHA, the standard antioxidant, displayed the highest effectiveness at 93%.

The *in-vitro* antioxidant effect of reducing power capacity, represented graphically, BHA exhibited the highest reducing capacity at an absorbance of 1.6 at 700nm, followed by the leaf, seed, and pulp at 1.4, 1, and 0.2 at 700nm absorbance, at a concentration of 10mg/ml.

The *in-vitro* antioxidant effect of lipid peroxidation, conducted to assess the part of the jackfruit tree extract that could effectively prevent cellular abnormalities caused by free radicals by breaking down the chain reactions responsible for lipid peroxidation, showed that BHA was the most effective at 55%, followed by the leaf at 50%, seed at 35%, and the pulp at 29%. The bar chart represents the EC_{50} (half-maximal effective concentration), IC*50* (half-maximal inhibitory concentration), $OD_{0.5}$ (concentration of the sample at 0.5 absorbance), and BHA as the standard antioxidant. Overall, BHA displayed the highest antioxidant activity followed by the leaf, seed, and pulp.

CONCLUSION

Jackfruit, a tropical tree, stands out as a bountiful source of essential nutrients, including carbohydrates, proteins, vitamins, minerals, dietary fiber, and an array of phytochemicals. This investigation underscores that jackfruit pulp excels in most of the analyzed nutrients. Jackfruit pulp, seeds, and leaves exhibit low levels of phytic acid, saponins, and alkaloids, while they are rich in flavonoids, tannins, and oxalates, which contribute to the health-enhancing attributes of jackfruit and its potent antioxidant effects. Moreover, it's imperative to delve deeper into the manifold health benefits that jackfruit offers, spanning its potential anticarcinogenic, antimicrobial, antifungal, anti-inflammatory, wound-healing, and hypoglycemic properties.

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