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EVALUATION OF *CARICA PAPAYA* SEEDS' NUTRITIONAL, PHYTOCHEMICAL, ANTINUTRITIONAL AND ANTIOXIDANT PROPERTIES

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Abstract

Carica papaya seeds are full of bioactive compounds that may have major health benefits despite being thrown out a lot of the time. In order to assess the *Carica papaya* seeds' potential for use in food and medicine, this study looks into their antioxidant, phytochemical, antinutritional, and nutritional qualities. Papaya seeds from *Carica* were gathered and dried, and their phytochemical content was examined using accepted techniques (Harborne 1973). Using TPC and DPPH assays, antioxidant activity was evaluated (Blois 1958; Re *et al.*, 1999). AOAC (2005) methods were used to determine the nutritional composition and Day and Underwood (1986) established protocols were used to quantify antinutritional factors. Significant concentrations of tannins, flavonoids, alkaloids, and saponins were found by the phytochemical analysis. Strong free radical scavenging activity was shown by antioxidant assays with low IC50 values in the DPPH assays. Antinutritional analysis found moderate levels of oxalates, phytates, and tannins which may have an impact on nutrient bioavailability, while nutritional analysis revealed

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high levels of protein, fat, and fiber. Papaya seeds from *Carica* are a promising option for functional foods and pharmaceutical applications because they are high in antioxidants, phytochemicals, and vital nutrients. To maximize their positive effects on health, their antinutritional components should be properly controlled.

Introduction

A tropical fruit well-known for its nutritional and therapeutic qualities is the *Carica papaya L.,* also referred to as papaya. The flesh of the fruit is commonly eaten, but even though the seeds may be healthy, they are frequently thrown away. Prior research has demonstrated that *Carica papaya* seeds are rich in bioactive substances such as alkaloids, flavonoids, and phenolics which are well-known for their medicinal and antioxidant properties (Krishna *et al.,* 2008. On the other hand, antinutritional factors such as oxalates, phytates, and tannins found in *Carica papaya* seeds can hinder the absorption of nutrients and may be harmful to health if ingested in excess (Enechi & Odonwodo 2003). With a view to determining their potential applications in the food and pharmaceutical industries, this study intends to offer a thorough assessment of the antioxidant, phytochemical, antinutritional, and nutritional qualities of *Carica papaya* seeds with a view to their potential application in food and pharmaceutical industries.

Sample Collection and Preparation

Fresh *Carica papaya* fruits were obtained from Dutsin-Ma Central Market, Katsina State, Nigeria. The seeds were manually separated, washed, air-dried, and authenticated at the Department of Biological Sciences, Federal University of Dutsin-Ma, where a voucher identification number; 0139, was assigned. The dried seeds were pulverized into fine powder and stored in airtight containers prior to analysis. Laboratory analyses were conducted and at the National Research Institute for Chemical Technology (NARICT), Zaria.

Phytochemical Analysis

To analyse the phytochemical composition of the *Carica papaya* seed samples, standard qualitative and quantitative methods were used.

Qualitative Analysis

Qualitative phytochemical screening for alkaloids, flavonoids, tannins, saponins, and phenolic compounds was carried out using standard methods described by Harborne (1973) and Trease and Evans (1989).

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Quantitative Analysis

Quantitative estimation of selected phytochemicals was performed using spectrophotometric methods as described in previous studies (Park *et al.,* 2019).

Antioxidant Activity potency

Antioxidant activity was evaluated using the DPPH free radical scavenging assay following the method of Blois (1958). The IC value was calculated from the dose–response curve. Total phenolic content was determined using the Folin–Ciocalteu method and expressed as mg gallic acid equivalents per gram (mg GAE/g) of extract (Re *et al.,* 1999).

Nutritional and Antinutritional Analysis

Association of Official Analytical Chemists (AOAC) 2005 methods were used to determine the nutritional composition, which included protein, fat, fibre, and ash content. Mineral elements were analyzed using atomic absorption spectrophotometry (AAS) after acid digestion. The techniques described by Day and Underwood (1986) were used to quantify antinutritional factors such as tannins, phytates, and oxalates.

Proximate Evaluation

The proximate composition, which included moisture content, crude protein, crude fat, ash, and crude fibre, was ascertained using the techniques of the AOAC (Association of Official Analytical Chemists).

Moisture Content: Drying in an oven at 105°C until the weight didn't change was how the moisture content was ascertained.

Crude Protein: Analysed using the Kjeldahl method, which multiplies the nitrogen content by a factor of 6.25 to convert it to protein.

Crude Fat: The extraction of crude fat employs the Soxhlet extraction method with petroleum ether as the solvent.

Ash Content: the samples were burnt in a muffle furnace at 550°C until a white ash was produced.

Crude fibre is estimated by weighing, drying, and filtering it following acid-base digestion.

Mineral Examination

The percentage of minerals (e.g., magnesium, iron, zinc, and calcium) was determined by putting the samples in a concentrated nitric acid and perchloric acid solution. The samples were then analysed using an atomic absorption spectrophotometer (AAS).

Statistical Analysis

All analyses were conducted in triplicate, and results are expressed as mean ± standard deviation (SD). Differences among means were considered statistically significant at $p < 0.05$.

Phytochemicals Composition

Carica papaya seeds contains a number of bioactive ingredients, including alkaloids, flavonoids, tannins, and saponins, according to a phytochemical analysis.

Table 1. Quantitative phytochemical composition of *Carica* papaya seeds

Phytochemical	Concentration (% w/w)	Mean ± SD
Alkaloids	6.60	6.60 ± 0.41
Flavonoids	7.04	7.04 ± 0.39
Tannins	15.63	15.63 ± 0.84
Saponins	64.37	64.37 ± 2.11

The concentrations of phytochemicals differed significantly among the detected constituents ($p < 0.05$), with saponins occurring at the highest level.

Flavonoid Content: *Carica* papaya has a fair amount of flavonoids, which have been shown to have anti-inflammatory and cardioprotective properties in addition to other health benefits. The flavonoid content was measured at 517 nm.

Tannin Content: There were 15.63 ± 0.84 tannins in the dry sample. Tannins are beneficial because of their astringent qualities and possible health advantages, such as their antioxidant activity. Papaya *Carica* seeds contains certain nutrients that are known to have immune-stimulating and cholesterol-lowering effects.

Saponin Content: A measurement of the saponin content of the dry samples revealed 64.37 ± 2.11 percent for papaya *Carica* seeds. These findings suggest that the significant concentration of bioactive phytochemicals found in *Carica* papaya seeds may be the source of some of its health-promoting qualities.

DPPH Radical Scavenging Activity

Table 2. DPPH radical scavenging activity of *Carica* papaya seed extract compared with ascorbic acid

Concentration (mg/mL)	%RSA (Papaya seed extract)	%RSA (Ascorbic acid)
4	18.0 ± 1.2	25.0 ± 1.0
8	38.9 ± 1.5	50.0 ± 1.3

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Concentration (mg/mL)	%RSA (Papaya seed extract)	%RSA (Ascorbic acid)
12	60.0 ± 1.8	70.0 ± 1.6
16	74.8 ± 2.0	85.0 ± 1.4
20	89.0 ± 1.8	95.0 ± 1.2

The radical scavenging activity increased significantly with extract concentration ($p < 0.05$). The IC 50 value of the seed extract was calculated as 2.65 mg/mL, indicating strong antioxidant potential.

Total Phenolic Content (TPC)

The total phenolic content of the papaya extract from *Carica* is determined using the TPC assay and expressed as milligrams of gallic acid equivalents per gramme (mg GAE/g) of sample.

Table 3. Total phenolic content of *Carica* papaya seed extract

Concentration (µg/mL)	TPC (ug GAE/g)
20	223.0 ± 15.4
40	136.2 ± 92.6
60	126.6 ± 388.1
80	153 ± 412.0
100	936.1 ± 41.7

Total phenolic content varied significantly with extract concentration ($p < 0.05$), with the highest value observed at 80 µg/mL.

Nutritional Profile

Due to proximate and mineral analyses, it was possible to understand the nutritional makeup of *Carica* papaya seeds.

Table 4. Proximate composition of *Carica* papaya seeds (% dry weight)

Component	Percentage (%)
Moisture	8.50 ± 0.32
Ash	4.25 ± 0.18
Protein	23.50 ± 1.12
Fat	26.75 ± 1.03
Fibre	18.00 ± 0.89
Carbohydrates	19.00 ± 0.97

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The results indicate that the seeds are rich in protein, fat, and dietary fibre, contributing to their nutritional value.

Mineral Composition:

The analysis of the mineral content showed the presence of necessary minerals. The concentrations of each of the nine mineral elements in the *Carica* papaya samples are listed in the table. minerals. Concentration in parts per million, or ppm, is used to display the results.

Table 5. Mineral composition of *Carica* papaya seeds (ppm)

Mineral	Concentration (ppm)
Ca	0.000077
Mg	0.0067597
K	0.0053731
Na	0.0000781
Fe	0.0009354
Zn	0.0002159
Mn	0.0000491
Co	0.0002782
Cu	0.0000707

The aforementioned results suggest that *Carica* papaya is a food item rich in nutrients, as it contains fair quantities of fat, protein, fibre, and essential minerals that are critical for preserving general health and wellness.

Antinutritional Profile

Results of Antinutrient Analysis

Table 6. Antinutritional composition of *Carica* papaya seeds

Antinutrients	Concentrations (mg/100 g)
Phytates	16.290 ± 0.62 mg/100g
Oxalates	1.4575 ± 0.09 mg/100g
Tannins	8.72 ± 0.41 mg/100g
Saponins	1.902 ± 0.12 mg/100g

All antinutritional factors differed significantly ($p < 0.05$) but were within acceptable ranges reported for edible plant materials.

Phytochemical composition

The high concentrations of phenolic flavonoids and alkaloids in *Carica* papaya seeds are primarily responsible for their antioxidant properties. These compounds are known to eliminate free radicals, which reduces oxidative stress and may lessen the likelihood of developing chronic illnesses (Krishna *et al.,* 2008).

Antioxidant Activity

The TPC and DPPH test results, which display high values, demonstrate the significant antioxidant capacity of *Carica* papaya seeds. Because *Carica* papaya seed has a low IC50 value 2.6548 for DPPH radical scavenging, it can effectively neutralise free radicals. Certain antioxidants, such as chlorogenic acid and quercetin tocopherols, highlight its potential as a useful natural antioxidant source. Prior research has indicated that the high phenolic and tocopherol contents of *Carica* papaya seeds contribute to their potent antioxidant activity (Iqbal *et al.,,* Sarker and collaborators, 2005). Because *Carica* papaya seed contains more antioxidants than other common seeds and nuts, it is marketed as a nutraceutical or functional food ingredient. Using it in food may increase the amount of antioxidants consumed and provide protection against diseases linked to oxidative stress.

Nutritional Value

The nutritional analysis shows that *Carica* papaya seeds are an excellent source of fat, protein, and dietary fibre—all of which are essential for human health. The mineral content of the seeds adds even more nutritional value, making them a potential ingredient in health-promoting foods (AOAC 2005).

Antinutritional Concerns

The antinutritional components phytates, tannins, and oxalates cause disadvantages for *Carica* papaya seeds even with their noteworthy nutritional benefits. According to Enechi and Odonwodo (2003), these compounds may make it more difficult for the body to absorb nutrients, so appropriate processing techniques are needed to reduce their concentrations and enhance the nutritional content and safety of the seeds.

Oxalates

At 1.4575 mg/100 g, *Carica papaya* has a moderate amount of oxalate content, which is similar to other plant-based foods. Oxalates have been shown to form insoluble complexes with calcium, which may decrease calcium absorption and raise the risk of kidney stones (Noonan and Savage 1999). *Carica papaya* has a moderate oxalate content, but people who have had kidney stones in the past should consume less of it.

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Tannins

Carica papaya has a concentration of 1.563 mg/100 g. Butler (1989) found that although tannins have been shown to disrupt protein digestion and lower iron bioavailability, *Carica* papaya seed contains a moderate amount of these compounds. Conversely, people with low iron levels or issues with protein digestion might find it advantageous to eat less *Carica papaya* seed tannin.

Saponins

Compared to other plant foods, *Carica* papaya seeds have a moderate saponin content of 6.437 mg/100 g. The metabolism of cholesterol may be impacted by saponins interference with lipid absorption (Gee *et al.,*, 1988). Even though *Carica* papaya seeds have a low saponin content, people who have problems with their lipid metabolism should be careful if they regularly eat them.

Phytates

The potential for mineral malabsorption is increased by the high phytate concentration of *Carica* papaya seeds (16.290 mg/100 g). When phytates attach to important minerals like calcium, iron, and zinc, they decrease their bioavailability, which can lead to dietary deficiencies (Erdman 1979). Consuming large amounts of *Carica papaya* can cause deficiencies in certain minerals, especially in populations where the average intake of minerals is already low.

Potential Applications

Carica papaya seeds have a rich phytochemical and nutritional profile that makes them suitable for use in pharmaceuticals, dietary supplements, and functional foods. Further research is required to optimise processing techniques in order to minimise the negative effects of antinutritional factors and maximise their health benefits.

In summary, the present study demonstrates that *Carica* papaya seeds possess a rich phytochemical profile and strong antioxidant capacity. The high levels of phenolics and flavonoids likely account for the observed DPPH radical scavenging activity, supporting earlier reports on the antioxidant potential of papaya seeds (Krishna *et al.,* 2008; Iqbal *et al.,* 2005). The low IC 50 value obtained indicates effective free radical neutralization, suggesting possible protective roles against oxidative stress–related disorders.

The proximate composition highlights the seeds as a valuable source of plant protein, lipids, and dietary fibre, which are essential for metabolic functions and gastrointestinal health. Although antinutritional factors were detected, their concentrations were

moderate and can be reduced through processing techniques such as roasting, fermentation, or soaking (Enechi & Odonwodo, 2003; Erdman, 1979).

CONCLUSION

This study demonstrates that because *Carica* papaya seeds are a rich source of antioxidants, phytochemicals, and essential nutrients, they represent a promising alternative for use in functional foods and pharmaceutical applications. However, because of the presence of antinutritional factors, their presence necessitates cautious processing to ensure safe consumption. It is crucial to keep researching ways to reduce these antinutritional chemicals in order to preserve the bioactive properties of the seeds. Further studies focusing on toxicity evaluation and product development are recommended.

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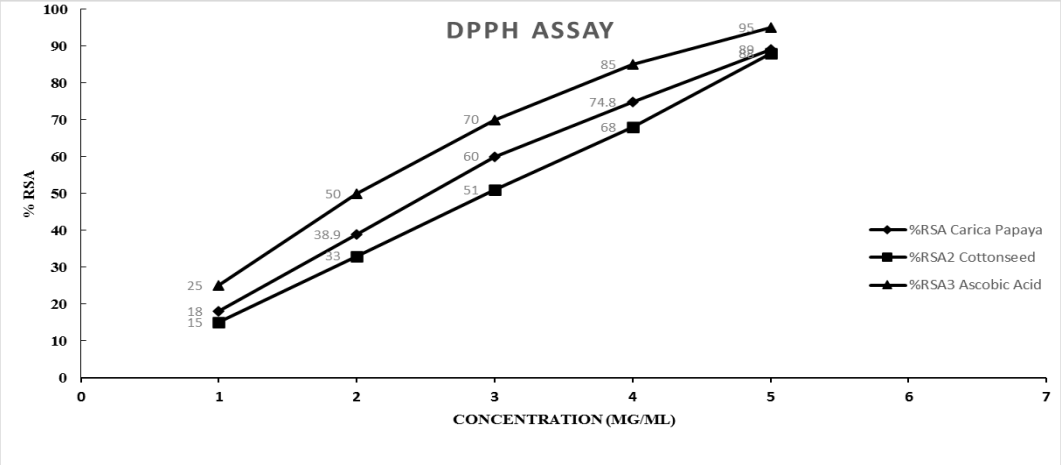
APPENDICES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