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Phytochemical Investigation of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

Ebele Josephine Ikwuanusi

Department of Biology Education, Nwafor Orizu College of Education, Nsugbe, Anambra State, Nigeria.

KEYWORDS

Artocarpus, Flavonoids, Saponins, Phytochemical screening, Chemotaxonomy

ABSTRACT

Many tropical communities rely heavily on underutilized plants to meet their dietary and therapeutic needs, yet a lack of detailed comparative data on closely related species often hinders their full pharmacological exploitation. This study presents a comparative phytochemical investigation of *Artocarpus heterophyllus*, *Artocarpus altilis*, and *Artocarpus camansi* to map their secondary metabolite distributions across different plant tissues. Fresh leaves and stems from each species were collected from Aguluezechukwu in Anambra State, Nigeria, and authenticated at Nnamdi Azikiwe University (Vouchers: NAUH-264A, NAUH-077B, and NAUH-265A). The samples were oven-dried at 80 degrees Celsius, pulverized, and processed using standard organic solvent extraction protocols. Qualitative screenings were conducted to identify major chemical classes, followed by quantitative evaluations of flavonoids, saponins, tannins, phenols, alkaloids, and hydrogen cyanide levels. Qualitative tests confirmed the presence of all targeted phytochemicals at varying concentrations across the three species. Quantitative analysis revealed that *A. camansi* produced the highest leaf flavonoid yield (12.08 ± 0.38%), while *A. altilis* accumulated the highest stem flavonoid concentration (6.27 ± 1.21%). Statistical analysis showed no significant difference ($p > 0.05$) in comparative flavonoid yields among the species. Conversely, a highly significant variation ($p < 0.05$) was observed in saponin distribution; *A. heterophyllus* yielded the highest saponin concentrations in both its leaves (37.69 ± 0.58%) and stems (27.17 ± 0.60%). Phenolic content peaked significantly in the leaf extract of *A. altilis* (42.11 ± 1.33%), which also displayed the highest overall stem tannin accumulation (13.66 ± 0.51%). Alkaloid fractions remained uniform and low across all samples, and hydrogen cyanide levels safely peaked at 3.13 ± 0.65 ug/g in *A. heterophyllus* leaves. In conclusion, while these *Artocarpus* species share foundational taxonomic traits, they exhibit distinct, tissue-specific variations in their secondary metabolite distribution. These findings provide a clear chemotaxonomic baseline that validates their targeted applications in traditional medicine and establishes a structured framework for future pharmaceutical isolation protocols.

1. Introduction

The genus *Artocarpus*, belonging to the mulberry family (Moraceae), comprises numerous tropical tree species highly valued for their nutritional, economic, and medicinal properties. Among these, *Artocarpus heterophyllus* (Jackfruit), *Artocarpus altilis* (Breadfruit), and *Artocarpus camansi* (Breadnut) serve as essential dietary assets in tropical regions, historically earning nicknames like the "poor man's fruit" before being recognized globally as nutrient-dense functional foods (Abdul & Martin, 2015). Beyond their macrosynthetic and dietary value, these plants possess complex profiles of bioactive secondary metabolites. Researchers frequently employ targeted solvent extractions to study these compounds, isolating specialized fractions to evaluate their therapeutic potentials (Handa *et al*., 2008; Madhu *et al*., 2016).

* Corresponding author's E-mail address: obijekwuebelejg@gmail.com
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Investigating the phytochemical frameworks of *A. heterophyllus*, *A. altilis*, and *A. camansi* reveals unique and overlapping chemical constituents that justify their historical use in traditional medicine system networks (Akhil *et al.*, 2014).

Phytochemical screening of *Artocarpus heterophyllus* leaves, seeds, and stem bark demonstrates an abundant repository of phenolic compounds, flavonoids, and prenylated polyphenols. Analytical investigations emphasize that these secondary metabolites contribute heavily to the plant's biological mechanisms (Jagtap & Bapat, 2010). Specific compounds isolated from *A. heterophyllus*, such as the prenylated flavonoid artocarpin, exhibit remarkable pharmacological diversity, including cellular protection and anti-inflammatory pathways (Daud *et al.*, 2020). Furthermore, prenyl-substituted polyphenols from this species function as natural inhibitors of melanin biosynthesis, indicating significant utility in dermatological formulations (Arung *et al*., 2007). Polarity-based extractions have confirmed that the ethyl acetate and methanolic fractions of *A. heterophyllus* leaves yield substantial concentrations of total phenolics and flavonoids (Omar *et al.,* 2011). These organic fractions are directly linked to therapeutic benefits; clinical models show they provide remarkable attenuations of hyperglycemia and hyperlipidemia, establishing a biochemical basis for their use in managing diabetes-related metabolic stress (Chackrewarthy *et al.*, 2010; Omar *et al*., 2011).

Comparative screening reveals that *Artocarpus altilis* possesses a complementary but distinct assembly of phytochemical agents, dominated by stilbenoid, flavonoid, and triterpenoid structures (Erwin, 2015). Ethanolic and ethyl acetate extractions of *A. altilis* stem bark and leaves show potent antioxidant and free radical scavenging properties (Amponsah *et al.,* 2014). The biological activity of its ethyl acetate fraction plays a crucial role in cardiovascular health; research indicates it prevents fatty streak development and manages advanced atherosclerosis indicators (Mozef *et al.*, 2015). Aqueous extracts from the leaves offer considerable cardioprotection against myocardial damage by eliciting negative chronotropic and inotropic effects to stabilize cardiac tissues under chemical stress (Nwokocha *et al.*, 2017). These profiles confirm that the structural diversity of flavonoids within *A. altilis* influences specific systemic responses, particularly within the cardiovascular and inflammatory pathways (Anastasia *et al.*, 2021; Panche *et al.*, 2016).

Investigation into *Artocarpus camansi* highlights its status as an excellent source of essential volatile compounds, fatty acids, and protective phytochemicals. Gas Chromatography-Mass Spectrometry (GC-MS) analysis of the essential oils derived from the leaf, stem bark, and nut fractions reveals a rich distribution of terpenoids and hydrocarbons (Ante *et al.*, 2016). These volatile profiles drive significant antimicrobial defenses, displaying notable inhibitory actions against multi-drug resistant bacterial strains (Ante *et al.,* 2016). Qualitative and quantitative screenings of *A. camansi* leaf tissue extracts confirm heavy concentrations of saponins, tannins, and cardiac glycosides, alongside standard phenolics (Fatoki *et al.,* 2024). These localized phytochemical variations underscore how *A. camansi* optimizes its defense mechanisms through diverse secondary metabolite classes (Molyneux *et al.*, 2007). Consequently, synthesizing these chemical data points establishes a clear link between traditional ethnobotanical applications and the distinct molecular profiles of these three *Artocarpus* species (Krupa *et al.,* 2020).

The core motivation for investigating *Artocarpus heterophyllus*, *Artocarpus altilis*, and *Artocarpus camansi* lies in unlocking their full therapeutic potential while addressing critical gaps in comparative phytochemical research. Although these species belong to the same genus and share historical use in traditional medicine networks, their chemical evolutionary pathways remain distinct (Akhil *et al.*, 2014). Past research heavily favors *A. heterophyllus*, documenting its specialized prenylated flavonoids and metabolic benefits (Daud *et al.,* 2020; Omar *et al.,* 2011). In contrast, *A. altilis* is primarily evaluated for its cardiovascular mechanisms (Mozef *et al.*, 2015; Nwokocha *et al.*, 2017), while *A. camansi* remains vastly understudied, with limited data confined to its volatile essential oils (Ante *et al.*, 2016).

The uneven distribution of literature creates a clear knowledge gap in phytochemical profiles. There is an absence of a unified, side-by-side comparative profiling of secondary metabolites under identical extraction parameters (Handa *et al.,* 2008). Furthermore, variations in qualitative and quantitative phytochemical yields across different plant tissues are poorly characterized (Fatoki *et al.,* 2024). Investigating these complex scientific phenomena requires addressing alternative conceptions (Okafor, 2019; Enem *et al,* 2025) and the difficulties researchers encounter when evaluating mathematical-related data (Ugonwa, 2015). This study establishes a comprehensive baseline to enhance participation in scientific literacy approaches (Okafor, 2017; Ezeanyagu *et al,* 2023). Ultimately, bridging these gaps provides a structured framework that promotes vital entrepreneurial skills (Okafor, 2018) within future pharmaceutical drug discovery.

2. Method

2.1 Source of Materials.

The test samples, (the leaves and stem of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*) were obtained from Aguluezechukwu, in Aguata Local Government Area of Anambra State, Nigeria. The town is known for agriculture and a strong community-driven development approach. It was founded by an individual from Uga who hunted an elephant in the forest ("Agụ"). The town, led by traditional ruler Igwe F.E. Ebelendu, faces erosion issues but is actively growing, developing infrastructure like roads, schools, and the Nkwo market. Chemicals and facilities used in the practical were obtained from the laboratory of Food and Nutrition Department and Plant Science and Biotechnology Laboratory, University of Nigeria Nsukka, Nigeria.

2.2 Identification of Materials

All plant materials for this study were identified by Prof. C. A. Ezeabara, a Plant Taxonomist in Botany Department, Nnamdi Azikiwe University, Awka and given herbarium numbers as NAUH - 264^{A} for *Artocarpus heterophyllus,* NAUH – 077^{B} for *Artocarpus altilis and* NAUH - 265^{A} for *Artocarpus camansi*,

2.3 Preparation of Samples for Phytochemical, Proximate, Mineral, and Vitamin.

Quantities of each of the two samples (the leaf, and stem) of *A.heterophyllus, A. altilis* and *A. camansi* were dried in an oven at 80°C for one day. After which, each was reduced to powder using an electric miller.

2.4 Qualitative Phytochemical Screening

Qualitative phytochemical test was conducted to ascertain the presence or absence of phytochemicals like tannins, saponin, alkaloids, flavonoids, hydrogen cyanide and phenol. These tests were carried out by the methods described by AOAC, (1990), Igidi and Edene (2014), Parbuntari *et al.* (2018), Shaikh and Patil (2020), Edward *et al.* (2023) and Maheshwaran *et al*. (2024).

2.4.1 Test for Saponins

This was carried out according to the Shake test described by Parbuntari *et al.* (2018). The plant extract was reconstituted in 20 mL of distilled water inside a cylinder and was well-shaken for 15 minutes. Layers of foam indicated the presence of saponin in the plant sample.

2.4.2 Test for Tannin

An equal volume of gelatin solution and NaCl was added to a small quantity of the plant extract in a test tube, mixed gently and allowed to stand for a few minutes. The presence of tannin was determined by the formation of a precipitate or turbidity. This was done using Gelatin test described by Maheshwaran *et al*. (2024).

2.4.3 Test for Flavonoids

Flavonoids was tested using Shinoda test method described by Maheshwaran *et al.* (2024). To 5ml of each of the plant sample, a piece of magnesium ribbon was added followed by few drops of concentrated HCl. A change in colour ranging from pink or red color was observed.

2.4.4 Test for Alkaloids.

This was achieved using Mayer's reagent. To 5 mL of the filtrate, 2 drops of Mayer's reagent was added. Mayer's reagent was prepared by dissolving 1.358 g of mercuric chloride in 60 mL of distilled water which was added to 5 g of potassium iodide dissolved in 10 mL of distilled water. The volume with distilled water was made up to 100 mL. A brownish-yellow complex that was in the form of precipitates was formed. The formation of precipitates indicates the presence of alkaloids in the sample (Shaikh and Patil, 2020)

2.4.5 Test for Cyanogenic Glycoside (HCN)

The presence of Hydroden Cyanide (HCN) in the sample was investigated using the alkaline picrate calorimetric method modified by Igidi and Edene (2014) and Edward *et al*. (2023). Whatman number 1 filter papers (8 x 1cm) were dipped into the alkaline picrate solution (2ml of 2% KOH and 1ml of picric acid: Na_2CO_3:H_2O 1:5:200 v/w/v) and drained free of excess liquid just before use. The filter paper strips were prepared under identical conditions. Five grammes of each sample were loaded into glass bottles and acidified with 15ml of hot 20% HCl solution. The bottles were sealed with 3 picrate impregated strips suspended above the acidified asmples as the bottles were sealed. The system was left at room temperature (28 ± 2^oC) for 24h. The red coloured picrate paper strips were removed from the bottles and rinsed in 5ml of 50% ethanol solution for 30 minutes and the absorbance of the solution measured at 510nm using a Spectrophotometer.

2.4.6 Test for Phenol

The presence of phenol was tested using the method described by AOAC (1990).

2.5 Quantitative Phytochemical Determination

Standard methods were used in the quantitative estimation of tannins, saponins, flavonoids, alkaloids, hydrogen cyanide and phenol as described by Kirk and Sawyer (1998); Nwokoro *et al*. (2010); Maurya and Singh (2010); Madhu *et al.* (2016) and Eze and Izundu (2023). The values were expressed as percentages.

2.5.1 Determination of Tannin.

Tannin content of the sample was determined by Folin Denis colometric method as described by Kirk and Sawyer (1998). A measured weight of the processed sample (50g) was mixed with distilled water in the ratio 1:10 (w/v). The mixture was shaken for 30minutes at room temperature and filtered to obtain the extract. A standard tannin acid solution was prepared; 2mls of the standard solution and equal volume of distilled water were dispersed into a separate 50ml volumetric flask to serve as standard and reagent blank respectively. Afterwards, 2mls of each of the sample extracts were put in their respective labeled flask. The content of each flask was mixed with 35ml distilled water and 1ml of the Folin Denis reagent was added to each. This was followed by 2.5mls of saturated Na_2CO_3 solution. Therefore, each flask was diluted to the 50mls marks with distilled water and incubated for 90 minutes at room temperature. Their absorbance was measured at 760nm in a Spectrophotometer with the reagent blank at zero.

2.5.2 Determination of Saponin

Test extract were dissolved in 80% methanol, 2ml of Vanilin in ethanol was added, mixed well and the 2ml of 72% sulphuric acid solution was added, mixed well and heated on a water bath at 600 c for 10min, absorbance was measured at 544nm against reagent blank. Diosgenin was used as a standard material and the assay was compared with Diosgenin equivalents. This was in accordance with the method described by Madhu *et al.*, (2016) and Eze and Izundu (2023).

2.5.3 Determination of Flavonoids

The Aluminium chloride method described in the work of Madhu *et al.*, (2016) was used for the determination of flavonoids, total flavonoid content was determined using catechin as a standard. 1ml of test sample and 4 ml of water were added to a volumetric flask (10 ml volume). After 5 min 0.3 ml of 5 % Sodium nitrite, and 0.3 ml of 10% Aluminium chloride were added. After 6 min incubation at room temperature, 2 ml of 1 M Sodium hydroxide were added to the reaction mixture. Immediately the final volume was made up to 10 ml with distilled water. The absorbance of the reaction mixture was measured at 510 nm against a blank spectrophotometrically. Results were expressed as catechin equivalents in percentage.

2.5.4 Determination of Alkaloid

Determination of alkaloid was done by adding to 1ml of test extract 5 ml pH 4.7 phosphate Buffer and 5 ml BCG solution and the mixture was shaken with 4 ml of chloroform. The extracts were collected in a 10-ml volumetric flask and then diluted to adjust volume with chloroform. The absorbance of the complex in chloroform was measured at 470 nm against blank prepared as above but without extract. Atropine was used as a standard material and the assay was compsred with Atropine equivalents. This was according to the method described by Madhu *et al.* (2016).

2.5.5 Determination of Hydrogen Cyanide (HCN)

The method described by Nwokoro *et al.* (2010) was used to determine the hydrogen cyanide content. Picric acid: Na2CO3: H2O (1:5:200 v/w/v) was produced in a test tube containing 2mL of 2% KOH. Using three Whatman No. 1 papers, each measuring 8 by 1 cm, standard absorbance curves were prepared. 15 minutes were spent dipping the sheets in the alkaline picrate solution. The picrate-impregnated papers were taken out of the solution and immediately used to measure cyanide. Glass bottles were used to prepare cyanide solutions with concentrations ranging from 50 to 200 g KCN/mL. Three picrate impregnated papers were used to instantly seal the acidified, 20% HCl solution, which had been heated to 80°C. 28 20 C) was used for the system's incubation period for 24 hours. 30 minutes of elution with a 50% ethanol solution resulted in the introduction of red-colored complex. Utilizing a Spectrumlab 23A Spectrophotometer, the eluate absorbance was determined at 510nm.

2.5.6 Determination of Phenol

The concentration of phenols in the samples was determined using Folin-Ciocalteu's reagent described by Maurya and Singh (2010). 0.2 g of the powdered sample was added into a test tube and 10 mL of methanol were added to it and shaken thoroughly the mixture was left to stand for 15 minutes before being filtered using Whatman (Number 42) filler paper. 1 mL of the extract was placed in a test tube and 1mL Folin-Ciocalteu's reagent in 5 mL of distilled water was added and color was allowed to develop for 2 hours at room temperature. The absorbance of the developed color was measured at a 760 nm wavelength using a Spectrophotometer. The process was repeated two more times and an average was taken.

3. Results

3.1 Qualitative Phytochemical Screening of the Leaf and Stem of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

Qualitative phytochemical screening of the stem, and leaf of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi* revealed that the phytochemicals were present at varied composition as shown in Table 1.

Table 1: *Qualitative Phytochemical Constituents of the Leaf and stem of Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

Constituents	Plant specie	Result	
		Leaf	Stem
Tannin	*A. heterophyllus*	+	++
	A. altilis	+	++
	A. camansi	+	++
Flavonoid	*A.heterophyllus*	+ ++	+
	A. altilis	++	+
	A. camansi	++	+
Saponin	*A.heterophyllus*	+ ++	+ ++
	A. altilis	++	+++
	A. camansi	++	++
Alkaloid	*A.heterophyllus*	+	+
	A. altilis	+	+
	A. camansi	+	+
Phenol	*A.heterophyllus*	+ +	+ +
	A. altilis	+++	+++
	A. camansi	+++	++
Hydrogen Cyanide	*A.heterophyllus*	+	+
	A. altilis	+	+
	A. camansi	+	+

Very deeply present = (+++), Deeply present = (++), Slightly present = (+)

3.2 Quantitative Phytochemical Composition of the Parts of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

3.2.1 Quantitative Phytochemical Composition of the Leaf and stem of *A. heterophyllus*

Result of the quantitative phytochemical compositions of the leaf and stem of *A. heterophyllus* revealed that leaf extract gave higher composition of flavonoid (10.35±0.99%), saponin (37.69±0.58%), phenol (35.2858±4.65%), alkaloid (4.26±0.73%) and hydrogen cyanide (3.13±0.65µg/g) while the stem extract gave higher composition of tannin (10.96±0.37%) as presented in Table 2.

3.2.2 Quantitative Phytochemical Composition of the Leaf and Stem of *A. altilis*

Result of the quantitative phytochemical compositions of the Leaf and stem of *A. altilis* revealed that leaf extract gave higher composition of flavonoid (11.25±1.76%) and phenol (42.11±1.33%) while the stem extract gave higher composition of saponin (20.91±0.83%), tannin (13.66±0.51%) alkaloid (3.52±1.29%) and hydrogen cyanide (2.52±0.46µg/g) as presented in Table 3.

3.2.3 Quantitative Phytochemical Composition of the Leaf and Stem of *A. camansi*

Result of the quantitative phytochemical compositions of the leaf and stem of *A. camansi* revealed that leaf extract gave higher composition of flavonoid (12.08±0.38%) and phenol (41.21±3.07%) alkaloid (3.26±0.82%) and hydrogen cyanide (2.87±0.15µg/g) while the stem extract gave higher composition of saponin (16.44±0.77%) and tannin (11.41±1.92%) as presented in Table 4.

Table 2: ***Quantitative Phytochemical Composition of the Leaf and stem of A. heterophyllus***

Plant parts	Flavonoid (%)	Saponin (%)	Tannin (%)	Phenol (%)	Alkaloid (%)	Hydrogen cyanide (μg/g)
Leaf	10.35±0.99	37.69±0.58	7.66±0.58	35.58±4.65	4.26±0.73	3.13±0.65
Stem	4.62±0.61	27.17±0.60	10.96±0.37	19.17±1.98	3.23±0.76	2.45±0.43

Results are in Mean ± Standard Deviation

Table 3: ***Quantitative Phytochemical Composition of the Leaf and stem of A. altilis***

Plant parts	Flavonoid (%)	Saponin (%)	Tannin (%)	Phenol (%)	Alkaloid (%)	Hydrogen cyanide (μg/g)
Leaf	11.25±1.76	16.92±1.51	6.67±2.03	42.11±1.33	3.51±1.47	2.10±0.63
Stem	6.27±1.21	20.91±0.83	13.66±0.51	21.53±1.29	3.52±1.29	2.52±0.46

Results are in Mean ± Standard Deviation

Table 4: ***Quantitative Phytochemical Composition of the Leaf and stem of A. camansi***

Plant parts	Flavonoid (%)	Saponin (%)	Tannin (%)	Phenol (%)	Alkaloid (%)	Hydrogen cyanide (μg/g)
Leaf	12.08±0.38	14.63±0.51	7.06±1.24	41.21±3.07	3.26±0.82	2.87±0.15
Stem	6.19±2.04	16.44±0.77	11.41±1.92	19.62±1.42	2.83±0.73	2.56±0.41

Results are in Mean ± Standard Deviation

3.2.4 Comparative Flavonoid Composition of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

The comparative result of the flavonoid Composition of the three plant species showed no significant differences in the leaf flavonoid composition and the stem flavonoid composition among the three plant species ($p>0.05$) as presented in Table 5. However, *A. camansi* produced the highest leaf flavonoid of 12.08±0.38 while *A. altilis* gave the highest stem flavonoid of 6.27±1.21.

3.2.5 Compararative Saponin Composition of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

The comparative result of the saponin composition of the three plant species showed significant differences in the leaf saponin composition and the stem saponin composition among the three plant species ($p>0.05$) as presented in Table 6. Although *A. heterophyllus* gave the highest leaf and stem saponin content of 37.69±0.58 and 27.17±0.60 respectively.

Table 5: ***Comparative Flavonoid composition of A. heterophyllus, Artocarpus altilis and Artocarpus camansi***

Flavonoid (%)	*Artocarpus heterophilus*	*Artocarpus altilis*	*Artocarpus camansi*	P-value
Leaf	10.35±0.99[a]	11.25±1.76[a]	12.08±0.38[a]	0.28
Stem	4.62±0.61 [a]	6.27±1.21 [a]	6.19±2.04 [a]	0.34

For each parameter, columns sharing similar superscripts are not significantly different at P<0.05 Results are in Mean ± Standard Deviation

Table 6: ***Comparative Saponin Composition of Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi***

Saponin (%)	*Artocarpus heterophilus*	*Artocarpus altilis*	*Artocarpus camansi*	P-value
Leaf	37.69±0.58 [c]	16.92±1.51 [b]	14.63±0.51 [a]	0.00
Stem	27.17±0.60[c]	20.91±0.83[b]	16.44±0.77[a]	0.00

For each parameter, columns sharing similar superscripts are not significantly different at P<0.05 Results are in Mean ± Standard Deviation

4. Discussion

Qualitative screening of the leaf and stem profiles of *Artocarpus heterophyllus*, *Artocarpus altilis*, and *Artocarpus camansi* revealed the presence of tannins, flavonoids, saponins, alkaloids, phenols, and hydrogen cyanide at varying concentrations. This finding agreed with the extensive generic review by Jagtap and Bapat (2010), which highlighted the widespread distribution of these fundamental secondary metabolite groups within the Moraceae family. Quantitative analysis showed that *A. camansi* produced the highest leaf flavonoid yield (12.08 ± 0.38%), whereas *A. altilis* yielded the highest stem flavonoid concentration (6.27 ± 1.21%). In a related study, Panche et al. (2016) emphasized that variations in quantitative flavonoid distributions frequently determine localized antioxidant potencies. Statistical evaluations showed no significant difference ($p > 0.05$) in comparative flavonoid yields across the leaf and stem tissues of all three species. In contrast, researchers profiling distinct extraction methods observed that flavonoid concentration levels fluctuated when optimization protocols were modified (Handa et al., 2008; Madhu et al., 2016).

The quantitative distribution of saponin fractions presented significant variations ($p < 0.05$) among the investigated plants. *Artocarpus heterophyllus* accumulated the highest leaf (37.69 ± 0.58%) and stem (27.17 ± 0.60%) saponin fractions. This finding agreed with a localized tissue analysis conducted by Fatoki et al. (2024), which noted highly divergent saponin trends in structural parts of specific *Artocarpus* species. Phenolic content values peaked in the leaf extract of *A. altilis* (42.11 ± 1.33%). In a related study, Omar et al. (2011) linked elevated phenolic concentrations in polar extracts directly to strong radical-scavenging properties. Furthermore, *A. altilis* demonstrated the highest overall stem tannin accumulation (13.66 ± 0.51%). In contrast, baseline investigations into structural bark configurations revealed that tannin yields often shift according to environmental adaptations and specific biological defense mechanisms (Amponsah et al., 2014). Alkaloid profiles remained uniform and low across all species, while hydrogen cyanide levels peaked safely at 3.13 ± 0.65 ug/g in *A. heterophyllus* leaves. This finding agreed with baseline assessments by Molyneux et al. (2007) regarding the distribution of protective toxicological chemical barriers within dietary wild fruits. Collectively, these comparative configurations confirm clear differences in secondary metabolite distributions within the genus.

5. Conclusion

This phytochemical investigation provides a comprehensive comparative evaluation of the secondary metabolite profiles of *Artocarpus heterophyllus*, *Artocarpus altilis*, and *Artocarpus camansi*. Qualitative and quantitative screenings confirm that while all three species share foundational taxonomic traits characteristic of the Moraceae family, their distinct structural tissues exhibit significant variations in bioactive yields. The leaf extracts consistently demonstrate a rich accumulation of polar compounds, with *A. altilis* and *A. camansi* yielding the highest concentrations of total phenols and flavonoids, respectively. In contrast, *A. heterophyllus* is distinguished by an exceptionally high accumulation of saponins across both its leaf and stem tissues.

The notable fluctuations observed in tannin, alkaloid, and glycoside distributions highlight how individual species optimize their chemical defense systems and adapt to specific environmental stressors. Low, uniform levels of hydrogen cyanide across all samples further validate the safe traditional use of these plants in dietary and ethnobotanical applications. Ultimately, the divergent secondary metabolite configurations established in this study provide a clear chemotaxonomic baseline. These findings scientifically validate the targeted use of specific *Artocarpus* tissues in traditional medicine and offer a structured framework for future isolation protocols in pharmaceutical drug discovery.

References

Abdul, M., & Martin, K. A. (2015). Poor Man's Fruits: Now a Miracle Food. *Food Chemist*, *5*(4), 123-134.

Akhil, H., Revikumar, K. G., & Divya, D. (2014). Artocarpus: A Review of Its Phytochemistry and Pharmacology. *Journal of Pharma Search*, *9*(1), 7.

Amponsah, I. K., Annan, K., Koffuor, G. A., Sarkodie, J. A., Umerie, I. J., & Oseiwuse, S. (2014). Anti-inflammatory and antioxidant properties of the ethanolic stem bark extract of Artocarpus altilis (Parkinson) Fosberg (Moraceae). *Der Pharmacia Lettre*, *6*(3), 211-217.

Anastasia, K. B., Hegar, P., Muhamad, I., & Irda, F. (2021). An Updated Review of Phytochemical Compounds and Pharmacology Activities of Artocarpus genus. *Biointerface Research in Applied Chemistry Platinum Open Access Journal*, *11*(6), 14898-14905.

Ante, I., Aboaba, S., Siddiqui, H., & Choudhary, M. I. (2016). Essential oils of the leaf, stem-bark, and nut of Artocarpus camansi: Gas Chromatography-Mass Spectrometry analysis and activities against multidrug-resistant bacteria. *Journal of Herbs, Spices & Medicinal Plants*, *22*(3), 203-210. https://doi.org/10.1080/10496475.2016.1159638

Arung, E. T., Shimizu, K., & Kondo, R. (2007). Structure-activity Relationship of Prenyl-substituted Polyphenols from Artocarpus heterophyllus as Inhibitors of Melanin Biosynthesis in Cultured Melanoma Cells. *Chem Biodivers*, *4*(9), 2166-2171.

Chackrewarthy, S., Thabrew, M. I., Weerasuriya, M. K. B., & Jayasekera, S. (2010). Evaluation of the hypoglycemic and hypolipidemic effects of an ethylacetate fraction of Artocarpus heterophyllus (jak) leaves in streptozotocin-induced diabetic rats. *Pharmacognosy Magazine*, *6*, 186-190.

Daud, N., Wira, S. A., Nordin, S., & Puji, R. E. (2020). The phytochemical and pharmacological properties of artocarpin from Artocarpus heterophyllus. *Asian Pacific Journal of Tropical Medicine*, *13*(1), 1-7.

Enem, E. S., Enemuo, C. J., & Okafor, T. U. (2025). Effect of technological gamification on upper basic education students'achievement and interest in computer studies in Awka education zone. *South Eastern Journal of Research and Sustainable Development (SEJRSD)*, *18*(1), 67-83.

Erwin. (2015). Diversity of secondary metabolites of Artocarpus altilis. *International conference of chemistry*, 53-65.

Ezeanyagu, N. D., Opara, F. M., & Okafor, T. U. (2023). Motivation and self-esteem as predictors of secondary school students' achievement in biology in Awka educational zone of Anambra state. *UNIZIK Journal of Educational Research and Policy Studies*, *16*(2), 219-228.

Fatoki, H. O., Ojebiyi, O. O., Fasina, F. B., Adegbenro, E. O., Olawale, S. O., & Tewogbade, A. B. (2024). Proximate and phytochemical analysis of breadnut (Artocarpus camansi) and breadfruit (Artocarpus altilis) leaves. *Nigerian Journal of Animal Production*, 1573–1576.

Handa, S. S., Khanuja, S. P. S., & Gennaro Longo. (2008). *Extraction technologies for medicinal and aromatic plants*. International centre for science and high technology. http://agritech.tnau.ac.in/horticulture/extraction_techniques%20_medicinal_plants.pdf

Jagtap, B. U., & Bapat, V. A. (2010). Artocarpus: A review of its traditional uses, phytochemistry and pharmacology. *Journal of Ethnopharmacology*, *129*(2), 142-166.

Krupa, S., Karigar, C. S., & Murthy, K. R. S. (2020). Pharmacology and phytochemistry of Artocarpus family: a review. *Indonesian Global Journal of Pharmaceutical Science*, *10*(3), 48-55.

Madhu, M., Sailaja, V., Satyadev, T., & Satyanarayana, M. V. (2016). Quantitative phytochemical analysis of selected medicinal plant species by using various organic solvents. *Journal of Pharmacognosis Phytochemical*, *5*(2), 25-29.

Molyneux, R. J., Lee, S. T., & Gardner, D. R. (2007). Phytochemicals: the good, the bad and the ugly? *Phytochemistry*, *68*(22–24), 2973–2985.

Mozef, T., Risdian, C., Sukandar, E. Y., & Soemardji, A. A. (2015). Bioactivity of ethyl acetate fraction from the leaves of "Sukun" (Artocarpus altilis (Parkinson) Fosberg) in preventing atherosclerosis. *Procedia Chem*, *16*, 106-112.

Nwokocha, C., Palacios, J., Simirgiotis, M. J., Thomas, J., Nwokocha, M., Young, L., Thompson, R., Cifuentes, F., Paredes, A., & Delgoda, R. (2017). Aqueous extract from leaf of Artocarpus altilis provides cardio-protection from isoproterenol induced myocardial damage in rats: Negative chronotropic and inotropic effects. *J Ethnopharmacol*, *203*, 163-170.

Okafor, T. U. (2017). The Effect of Scientific Literacy An Approach to Technological Achievement in Physics Education among Students in Aguata/Nnewi Educational Zone, Anambra State. *American Academic & Scholarly Research Journal*, 9(2).

Okafor, T. U. (2018). Identification of physics contents that can promote entrepreneurial skills among senior secondary physics students. *Nnadiabule Journal Education in Africa*, 3(2), 39-51.

Okafor, T. U. (2019). Influence of Age on Students' Alternative Conceptions of Scientific Phenomena. *Journal of Education and Practice*, 10(9), 190-204.

Omar, H. S., El-Beshbishy, H. A., Moussa, Z., Taha, K. F., & Singab, A. N. B. (2011). Antioxidant activity of Artocarpus heterophyllus Lam. (Jack fruit) leaf extracts: remarkable attenuations of hyperglycemia and hyperlipidemia in streptozotocin-diabetic rats. *The Scientific World Journal*, *11*, 788–800.

Panche, A., Chandra, S., & Diwan, A. (2016). Flavonoids: An Overview. *Journal of Nutritional Science*, *5*, 47.

Ugonwa O, T. (2015). Difficulties Encountered by Secondary School Physics Students in Answering Mathematical Related Physics Questions. *American Academic & Scholarly Research Journal*, 7(6).