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Comprehensive comparative assessment of the quantity and quality of constituents among the three species of *Artocarpus*

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ABSTRACT

This study conducted a comprehensive comparative assessment of the quantity and quality of phytochemical constituents present in three economically and nutritionally important species of the genus Artocarpus: Artocarpus heterophyllus (jackfruit), Artocarpus altilis (breadfruit), and Artocarpus camansi (breadnut). Leaf and stem samples of the three species were collected and analyzed for selected phytochemical constituents, including tannins, phenols, alkaloids, and hydrogen cyanide, using standard analytical procedures. Data obtained were subjected to statistical analysis to determine variations among species. The results revealed no significant differences ($p > 0.05$) in the concentrations of tannins, phenols, alkaloids, and hydrogen cyanide in both leaves and stems across the three species. Nevertheless, A. heterophyllus recorded the highest leaf tannin (7.66±0.58%), leaf alkaloid (4.26±0.73%), and leaf hydrogen cyanide (3.13±0.65 µg/g) contents. A. altilis exhibited the highest stem tannin (13.66±0.51%), stem alkaloid (3.52±1.29%), and both leaf and stem phenol contents of 42.11±1.33% and 21.53±1.29%, respectively. A. camansi showed the highest stem hydrogen cyanide value (2.56±0.41 µg/g). The generally comparable phytochemical profiles observed among the species indicate close biochemical relationships and suggest their potential as valuable sources of bioactive compounds. The low hydrogen cyanide levels further support their suitability for nutritional, pharmaceutical, and nutraceutical applications..

Introduction

Artocarpus heterophyllus (jackfruit), *Artocarpus altilis* (breadfruit), and *Artocarpus camansi* (breadnut) are closely related species within the Moraceae family and possess considerable nutritional and phytochemical importance. A comparative assessment of their constituents reveals significant similarities and differences in both the quantity and quality of nutrients and bioactive compounds, which determine their nutritional, medicinal, and industrial values. In terms of proximate composition, all three species are rich in carbohydrates, making them valuable energy sources. However, breadfruit (*A. altilis*) generally contains higher carbohydrate levels in its edible pulp and is widely recognized as a staple food crop capable of contributing to food security (Jones *et al.*, 2011; Heuzé *et al.*, 2017). Jackfruit (*A. heterophyllus*) also contains substantial carbohydrates, particularly sugars in the ripe fruit, which contribute to its sweet taste and high caloric value (Ranasinghe *et al.*, 2019; Hossain *et al.*, 2011). Breadnut (*A. camansi*) differs from the other species because its seeds contain higher protein and lipid concentrations, making it nutritionally comparable to legumes and other protein-rich plant foods (Adeleke & Abiodun, 2010; Mohammed & Wickham, 2011).

Protein quality varies considerably among the three species. Breadnut seeds possess the highest protein content and provide essential amino acids necessary for growth and tissue maintenance (Adeleke & Abiodun, 2010; Nelson-Quartey *et al*., 2007). Jackfruit seeds also contain appreciable protein levels and amino acids suitable for dietary supplementation (Ajayi & Adewale, 2013). In contrast, breadfruit pulp contains lower protein concentrations but remains an important source of dietary energy and micronutrients (Jones *et al.*, 2011).

The three species are also rich in dietary fibre, although the quantity differs among plant parts. Breadfruit and breadnut contain substantial fibre levels that support gastrointestinal health and may reduce the risk of cardiovascular diseases, obesity, and diabetes (Adaku *et al*., 2019; Alahmari, 2024). Jackfruit likewise contains considerable fibre, particularly in the fruit pulp and seeds, contributing to improved digestion and metabolic health (Ranasinghe *et al*., 2019). The presence of fibre enhances the nutritional quality of these species because dietary fibre plays a critical role in maintaining healthy gut function (Rana *et al*., 2025).

Mineral composition further demonstrates the nutritional superiority of the genus. Potassium, calcium, magnesium, phosphorus, and iron occur in varying concentrations across the three species. Jackfruit has been reported to contain appreciable levels of essential minerals necessary for electrolyte balance and physiological functioning (Ajayi, 2008). Breadnut seeds are particularly rich in minerals that support bone development and metabolic processes (Rabeta & Nor Syafiqah, 2016; Amadi *et al*., 2019). Breadfruit also contributes significant amounts of minerals and vitamins required for human nutrition (Jones *et al*., 2011).

Phytochemical constituents constitute another important aspect of quality assessment. The three species contain flavonoids, phenolics, tannins, saponins, alkaloids, and other secondary metabolites with medicinal properties (Akhil *et al*., 2014; Anastasia *et al*., 2021). Jackfruit exhibits particularly high concentrations of phenolic compounds and flavonoids, which contribute to its antioxidant, antidiabetic, antimicrobial, and anti-inflammatory activities (Omar *et al.,* 2011; Daud *et al.,* 2020). Breadfruit leaves and fruits contain bioactive compounds associated with cardiovascular protection and antioxidant functions (Nwokocha *et al*., 2017; Mozef *et al*., 2015). Breadnut similarly possesses phytochemicals with antimicrobial and therapeutic potentials, although the concentration and diversity of compounds may be lower than those reported for jackfruit (Ante *et al*., 2016; Salonga *et al.,* 2014). The genus *Artocarpus* comprises several species with recognized nutritional, medicinal, and economic importance; however, research has largely focused on individual species rather than direct comparative evaluations.

Studies on *Artocarpus heterophyllus* have emphasized its nutritional and therapeutic potentials (Ranasinghe et al., 2019), while investigations on *Artocarpus altilis* have concentrated mainly on food security and functional food applications (Jones et al., 2011). Similarly, *Artocarpus camansi* has been studied primarily for its nutritional composition (Adeleke & Abiodun, 2010). Despite these efforts, limited information exists regarding a comprehensive comparison of the quantity and quality of phytochemical constituents among the three species under similar conditions. This knowledge gap necessitated the present study to generate comparative data that can guide species selection for nutritional, pharmaceutical, and nutraceutical applications while enhancing the understanding of biochemical similarities and variations within the genus *Artocarpus*.

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*,

3. Results

3.1 Comparative Tannin Composition of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

The comparative tannin composition of the three plant species showed no significant differences in the leaf tannin composition and the stem tannin composition among the three plant species (p>0.05). However, *A. heterophyllus* gave the highest leaf tannin (7.66±0.58) while *A. altilis* gave the highest stem tannin value of 13.66±0.51 as presented in Table 1.

3.2 Comparative Phenol Composition of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

The comparative phenol composition of the three plant species showed no significant differences in the leaf phenol composition and the stem phenol composition among the three plant species (p>0.05). Interestingly however, *A. altilis* showed the highest leaf and stem phenol composition of 42.11±1.33 and 21.53± 1.29 respectively as shown in Table 2.

Table 1: ***Comparative Tannin composition of A. heterophyllus, A. altilis and A. camansi***

Tannin (%)	***Artocarpus heterophyllus***	***Artocarpus altilis***	***Artocarpus camansi***	**P-value**
Leaf	7.66±0.58 [a]	6.67±2.03 [a]	7.06±1.24[a]	0.71
Stem	10.96±0.37 [a]	13.66±0.51 [a]	11.41±1.92[a]	0.06

For each parameter, columns sharing similar superscripts are not significantly different at P<0.05

Results are in Mean ± Standard Deviation

Table 2: ***Comparative Phenol composition of A. heterophyllus, A. altilis and A. camansi***

Phenol (%)	***Artocarpus heterophilus***	***Artocarpus altilis***	***Artocarpus camansi***	**P-value**
Leaf	35.58±4.65 [a]	42.11±1.33 [a]	41.21±3.07 [a]	0.10
Stem	19.17±1.98 [a]	21.53±1.29 [a]	19.62±1.42 [a]	0.24

For each parameter, columns sharing similar superscripts are not significantly different at P<0.05

Results are in Mean ± Standard Deviation

3.3 Comparative Alkaloid Composition of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

The comparative result on the alkaloid composition of the three plant species showed no significant differences in the leaf alkaloid composition and the stem alkaloid composition among the three plant species (p>0.05). In spite of that, *A. heterophyllus* showed the highest leaf alkaloid composition of 4.26±0.73 while *A. altilis* gave the highest stem alkaloid composition of 3.52±1.29 as presented in Table 3.

3.4 Comparative Hydrogen Cyanide Composition of *Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi*

The comparative result on the hydrogen cyanide composition of the three plant species showed no significant differences in the leaf Hydrogen Cyanide composition and the stem hydrogen cyanide composition among the three plant species (p>0.05). Though, *A. heterophyllus* showed the highest leaf hydrogen cyanide composition of 3.13±0.65 while *A. camansi* gave the highest stem hydrogen cyanide composition of 2.56±0.41 as presented in Table 4.

Table 3: ***Comparative Alkaloid Composition of Artocarpus heterophyllus, Artocarpus altilis and Artocarpus camansi***

Alkaloid (%)	*A, heterophyllus*	*Artocarpus altilis*	*A. camansi*	P-value
Leaf	4.26±0.73 [a]	3.51±1.47 [a]	3.26±0.82[a]	0.52
Stem	3.23±0.76 [a]	3.52±1.29 [a]	2.83±0.73[a]	0.69

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

Table 4: ***Comparative Hydrogen Cyanide Composition of A. heterophyllus, A. altilis and A.camansi***

Hydrogen cyanide (µg /g)	***Artocarpus heterophyllus***	***Artocarpus altilis***	***Artocarpus camansi***	**P-value**
Leaf	3.13±0.65 [a]	2.10±0.63 [a]	2.87±0.15 [a]	0.12
Stem	2.45±0.43 [a]	2.52±0.46 [a]	2.56±0.41 [a]	0.95

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

4. Discussion

The comparative phytochemical assessment of *Artocarpus heterophyllus*, *Artocarpus altilis*, and *Artocarpus camansi* revealed no significant differences (p>0.05) in tannin, phenol, alkaloid, and hydrogen cyanide contents among the leaves and stems of the three species. Nevertheless, observable variations in mean values suggest species-specific tendencies in phytochemical accumulation. For tannin composition, *A. heterophyllus* recorded the highest leaf tannin content (7.66±0.58%), while *A. altilis* exhibited the highest stem tannin value (13.66±0.51%). This finding agreed with the report of Akhil et al. (2014), who noted that members of the *Artocarpus* genus possess appreciable quantities of tannins that contribute to their medicinal properties. In a related study, Anastasia et al. (2021) reported that tannins are among the dominant phytochemicals commonly distributed across *Artocarpus* species, supporting the absence of significant interspecific variation observed in the present study. In contrast, Daud et al. (2020) emphasized a greater concentration of specific bioactive compounds in *A. heterophyllus*, suggesting that environmental and plant-part differences may influence tannin accumulation.

The phenol composition showed that *A. altilis* had the highest leaf (42.11±1.33%) and stem (21.53±1.29%) phenol contents, although the differences were not statistically significant. This finding agreed with Mozef et al. (2015), who reported that *A. altilis* leaves contain substantial phenolic compounds responsible for antioxidant and anti-atherosclerotic activities. Similarly, Nwokocha et al. (2017) demonstrated the therapeutic potential of *A. altilis* leaf extracts, attributing such effects partly to their phenolic constituents. In a related study, Omar et al. (2011) reported high antioxidant activity in *A. heterophyllus* leaves due to abundant phenolic compounds. The slightly lower phenol values observed in *A. heterophyllus* in the present study therefore contrast with the strong phenolic activity previously documented for the species.

Regarding alkaloid composition, *A. heterophyllus* recorded the highest leaf alkaloid content (4.26±0.73%), whereas *A. altilis* showed the highest stem value (3.52±1.29%). This finding agreed with Akhil et al. (2014), who identified alkaloids as important phytochemical constituents across the *Artocarpus* genus. Likewise, Anastasia et al. (2021) reported widespread occurrence of alkaloids in *Artocarpus* species, supporting the similarity in alkaloid concentrations among the three species. In contrast, Daud et al. (2020) highlighted the predominance of specialized bioactive compounds such as artocarpin in *A. heterophyllus*, indicating qualitative differences despite the comparable quantitative alkaloid levels observed.

The hydrogen cyanide results showed no significant differences among species, although *A. heterophyllus* recorded the highest leaf value (3.13±0.65 µg/g) and *A. camansi* the highest stem value (2.56±0.41 µg/g). This finding agreed with the observations of Adeleke and Abiodun (2010), who reported that *A. camansi* possesses acceptable levels of antinutritional factors that do not compromise its nutritional quality. Similarly, Mohammed and Wickham (2011) noted that breadnut contains low concentrations of potentially toxic compounds, making it suitable for food applications after processing. In contrast, Ajayi and Adewale (2013) emphasized the safety of *A. heterophyllus* seed products, suggesting that cyanogenic compounds in the species occur at levels below toxic thresholds.

5. Conclusion

This study provided a comprehensive comparative assessment of the quantity and quality of constituents present in *Artocarpus heterophyllus*, *Artocarpus altilis*, and *Artocarpus camansi*. The findings revealed that the three species possess comparable phytochemical profiles, with no statistically significant differences observed in the concentrations of tannins, phenols, alkaloids, and hydrogen cyanide in both leaf and stem samples. Despite the absence of significant variation, slight differences in mean values highlighted the unique phytochemical tendencies of each species. *Artocarpus heterophyllus* exhibited relatively higher leaf tannin, alkaloid, and hydrogen cyanide contents, while *Artocarpus altilis* showed superior phenol concentrations and stem tannin and alkaloid contents. *Artocarpus camansi* demonstrated phytochemical levels that were generally comparable to those of the other species, confirming its nutritional and medicinal relevance within the genus. The substantial presence of beneficial phytochemicals such as phenols, tannins, and alkaloids suggests that all three species possess considerable antioxidant, antimicrobial, and therapeutic potential. Furthermore, the low hydrogen cyanide concentrations recorded indicate minimal toxicological concerns and support their safe utilization in food, pharmaceutical, and nutraceutical applications.

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