

Proximate composition, mineral and total phenolic contents, and scavenging activity of breadnut fruit (*Artocarpus camansi*)

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Abstract

This study investigated the proximate composition, mineral and total phenolic contents (TPCs), and antioxidant capacity of the core, pulp and seed of breadnut (*Artocarpus camansi*). For proximate composition, pulp had the highest ash (1.47%) and protein contents (1.29%), and core had the highest moisture content (88.6%). The minerals present in breadnut were calcium, zinc, copper, manganese, iron and sodium. The percentage of DPPH inhibition followed the order seed > pulp > core. The TPCs of the samples were 7.88 – 22.1 mg gallic acid equivalent (GAE)/g for methanol extract and 1.69 to 5.22 mg GAE/g for water extract. Evaluation provided a strong basis for the nutritional value of *A. camansi*, which is an underutilised fruit. Results revealed that breadnut is an edible underutilised fruit that is cheap, contains high value of antioxidant activity and can be beneficial to the food and health industries.

Keywords: proximate, mineral, total phenolic content, DPPH, *Artocarpus camansi*

Introduction

Phenolics are the most broadly distributed secondary plant metabolites that possess beneficial effects, such as free radical scavengers, thus preventing low-density lipoprotein and chelators of pro-oxidant metals (Shahidi and Naczka 2004). Plant polyphenols have attracted attention because of their potent antioxidant properties and preventive action on various oxidative stress associated with diseases, such as cancer (Dai and Mumper 2010).

Some underutilised fruits in Malaysia are rarely eaten, unknown and unfamiliar in the Peninsular and East Malaysia. These fruits have not received considerable attention as potential and cheaper natural antioxidant sources because they are unpopular among local communities, lack of information on nutritional compositions and

promotion (Ikram et al. 2009). *Artocarpus camansi* has often been considered to be a form of seeded breadfruit, *Artocarpus altilis*. It is oblong or sometimes round and has spiny skin with little pulp inside. Breadnut is known for its nutritious seeds (Ragone 2006). In Ghana, a new product development study was carried out to formulate an infant food from breadnut seeds (Nelson-Quartey et al. 2007).

Natural antioxidants from plants and herbs have recently become the main interest and focus in the food industry and traditional medicine. Synthetic or unnatural antioxidants, namely butylated hydroxyanisole (BHA) and butylated hydroxyl toluene (BHT), can cause some negative side effects and have carcinogenic properties (Brannen et al. 1975; Ito et al. 1983).

BHA and BHT are generally added in food during processing to delay lipid peroxidation process and consequently improve the shelf life of the food (Yu et al. 2002). Given the concerns about long-term safety, synthetic antioxidants have restricted use in food because they pose severe health risks (Hettiarachchy et al. 1996). This study aimed to analyse the proximate compositions and mineral contents of the different parts of *A. camansi*, determine the total phenolic contents (TPCs) of the seed, core and pulp by using the Folin-Ciocalteu (FC) assay, and identify any scavenging activity of the water and methanol extracts from the different parts of *A. camansi*.

Materials and methods

Artocarpus camansi fruits were collected from Parit Abas, Kuala Kurau, Perak, Malaysia. Mature fruits used as samples were identified by a botanist from the Herbarium Unit of Universiti Sains Malaysia.

The fruits were cleaned under running tap water to remove dirt and separated into seed, pulp and core. The small pieces of the fresh samples were ground using a normal grinder (Panasonic mx 7995). Then, the samples were dried for 48 h using a non-thermal dryer, freeze dryer (Alpha 1-2 LD Plus; Germany). The freeze-dried of three part of samples were ground using a normal grinder (Panasonic mx 7995), sieved to obtain a uniform fine powder, and stored in an air-tight container at $-20\text{ }^{\circ}\text{C}$ (Biomedical Freezer, Model MDF-136; Japan) prior to analysis.

The samples were analysed in duplicate for moisture, total ash, protein, fat and crude fibre by the methods of the Association of Analytical Chemist (AOAC 2000). Total carbohydrate content was calculated by subtracting the percentage of ash, protein, fat and fibre.

The mineral content of *A. camansi* was determined using an atomic absorption spectrophotometer for calcium, sodium, zinc, copper, iron and manganese. Standard

curves were prepared for the determination of the elements.

Based on the method proposed by Ikram et al. (2009), about 1 g of freeze-dried powder (core, seed and pulp) was extracted with 50 ml of 80% methanol (v/v). The mixture was placed in a conical flask and wrapped with an aluminium foil then put inside an incubator shaker (S1-600R; Korea) at 200 rpm at room $25\text{ }^{\circ}\text{C}$ for overnight. Then, the mixture was centrifuged using a benchtop centrifuge (Kubota-5100; Fujioka, Japan) at 3500 rpm at $25\text{ }^{\circ}\text{C}$ for 20 min.

Total phenolic content (TPC) was determined using FC reagent (Singleton and Rossi 1965). About 400 μl of the sample extract was added to 2 ml of FC reagent (10 times pre-diluted). After 5 min at $25\text{ }^{\circ}\text{C}$, 1.6 ml of (7.5% w/v) sodium carbonate was added. The solution was vortexed and stored in the dark at the previous temperature for 1 h. The absorbance was measured at 765 nm using an ultra violet (UV)-visible (vis) spectrophotometer (UV-160A; Shimadzu, Japan).

The scavenging activity of the samples was estimated using DPPH according to the method described by Abu Bakar et al. (2009). An aliquot of 300 μl of sample was mixed with 3 ml of 500 μM DPPH in absolute methanol. The mixture was then shaken energetically and allowed to stand at $25\text{ }^{\circ}\text{C}$ for 30 min in the dark. The absorbance of the mixture was then measured at 517 nm using the UV-vis spectrophotometer (UV-160A; Shimadzu, Japan).

Statistical analysis

Data were analysed using statistical package for social sciences (SPSS) version 17.0 for windows (SPSS Inc, Chicago, IL, USA). ANOVA and Duncan multiple range test method were used to compare any significant differences between solvents and samples. Data were expressed as mean \pm standard deviation of triplicate measurements. A $p < 0.05$ was considered statistically significant.

Results and discussion

Proximate composition

Moisture content of *A. camansi* core was highest ($88.4 \pm 0.08\%$), followed by pulp ($86.2 \pm 0.05\%$) and seed ($66.3 \pm 0.04\%$). A significant difference ($p < 0.05$) was observed in the moisture content among these samples. The moisture content of the seed obtained in this study was higher than that reported by Adeleke and Abiodun (2010) (60.96%) and Ragone (2006) (56.0 – 66.2%). Negron de Bravo et al. (1983) reported that the moisture contents of seed, pulp, and core of *A. camansi* are 11.5, 7.1 and 12.4% respectively, on a dry weight basis. Higher moisture content indicates higher perishability (Adeleke and Abiodun 2010).

Ash content was highest in the pulp of *A. camansi* ($1.47 \pm 0.02\%$), followed by the seed ($1.24 \pm 0.03\%$) and core ($1.12 \pm 0.03\%$). A significant difference ($p < 0.05$) was observed in the ash contents of the core, pulp and seed of the breadnut.

Previous studies on *A. camansi* seed (Negron de Bravo et al. 1983; Adeleke and Abiodun 2010) reported that the compositions of ash are 3.7% on a dry basis and 3.43% on a wet basis. Negron de Bravo et al. (1983) showed high values of core (11.7%) and pulp (3.7%) of *A. camansi*, which are higher than those obtained in this study. This result may be attributed to the different locations of the sample sites.

The highest fat content ($1.85 \pm 0.28\%$) was obtained in *A. camansi* seed, followed by pulp ($1.06 \pm 0.30\%$) and core ($0.62 \pm 0.01\%$). The seed showed a significant difference ($p < 0.05$) in fat content with

other parts of the fruit. Negron de Bravo et al. (1983) and Adeleke and Abiodun (2010) reported that the fat contents of *A. camansi* seed are 3.48% on a wet basis and 6.2% on a dry basis respectively. Negron de Bravo et al. (1983) also reported that the fat contents of core and pulp are 6.8% and 6.4% respectively, on a dry weight basis. The values were different and lower than the previous study possibly because of the difference in their growth habits, such as soil type, water source and cultural practices adopted during planting (Adeleke and Abiodun 2010).

Table 1 shows that the highest protein content is in *A. camansi* pulp ($1.29 \pm 0.15\%$), followed by seed ($1.12 \pm 0.02\%$) and core ($0.17 \pm 0.03\%$). A significant difference ($p < 0.05$) is observed in the protein content between the core and other parts of the fruit. Adeleke and Abiodun (2010) reported that the fresh weight value of seed is 4.87%, which is higher than the value obtained in this study. The seed protein contents of 13.3 – 19.9% and 13.3% in a dry weight basis are also reported (Negron de Bravo et al. 1983; Ragone 2006). A previous study showed that the protein content of *A. camansi* seed is highest because it contains an appreciable amount of protein, which is essential for growth and development as well as repair worn out tissues (Adeleke and Abiodun 2010). Moreover, the protein contents of pulp are 5.8% (dry basis) and 6.8% (dry basis) (Adeleke and Abiodun 2010).

The crude fibre composition of *A. camansi* seed was 2.72%, which was higher than the value reported by Adeleke

Table 1. Proximate composition of *Artocarpus camansi* (% wet basis)

	Moisture	Ash	Fat	Protein	Crude fibre	Carbohydrate
Core	$88.4 \pm 0.08c$	$1.12 \pm 0.03a$	$0.62 \pm 0.01a$	$0.17 \pm 0.03a$	$1.60 \pm 0.03a$	$8.14 \pm 0.05a$
Pulp	$86.2 \pm 0.05b$	$1.47 \pm 0.02c$	$1.06 \pm 0.30a$	$1.29 \pm 0.15b$	$2.13 \pm 0.01ab$	$7.81 \pm 0.42a$
Seed	$66.3 \pm 0.04a$	$1.24 \pm 0.03b$	$1.85 \pm 0.28b$	$1.12 \pm 0.02b$	$2.72 \pm 0.34b$	$26.8 \pm 0.01b$

Mean values \pm standard deviation (n = 2)

Values with different letters are significantly different at $p < 0.05$

and Abiodun (2010) on a wet basis. For a dry weight basis, the crude fibre content of the seed is 2.5% (Negron de Bravo et al. 1983).

The crude fibre compositions of the core and pulp of *A. camansi* were 2.13% and 1.60% respectively. A significant difference ($p < 0.05$) was observed between the crude fibre contents of the core and seed.

The carbohydrate content in seed was high (26.8%), which was similar to the value (26.11%) reported by Adeleke and Abiodun (2010). The carbohydrate contents of the pulp and core were 7.81% and 8.14% respectively. Negron de Bravo et al. (1983) reported that the carbohydrate contents of the seed, pulp and core are 76.2, 74.6 and 74.2% respectively, on a dry weight basis.

Mineral content

All results on mineral contents were reported on a wet basis. The most abundant mineral was calcium (Ca). The core shows the highest amount of Ca (159 mg/100 g), followed by the pulp (151 mg/100 g) and seed (126 mg/100 g). A significant difference ($p < 0.05$) was observed between the Ca content between samples (Table 2). Adeleke and Abiodun (2010) reported a Ca content of 185 mg/100 g. These results show that breadnut is rich in Ca and may support growth of stronger bones and teeth.

Zinc (Zn) was the second most abundant mineral content in breadnut. The highest Zn content was found in the pulp (44.0 mg/100 g), followed by the core (46.0 mg/100 g) and seed (28.5 mg/100 g). By ANOVA test, a significant difference ($p < 0.05$) was observed in the zinc content

between the *A. camansi* seed and other fruit parts.

The pulp contained 20.6 mg/100 g of ferrum (Fe). The Fe contents of the core and seed were almost similar to 15.4 and 15.8 mg/100 g respectively. The Fe content in *A. camansi* seed was lower than that reported by Adeleke and Abiodun (2010).

The sodium (Na) compositions in pulp, core and seed were 13.6, 9.75 and 4.50 mg/100 g respectively. Na is essential in regulating the water level in the human body and also balances the pH level. A significant difference ($p < 0.05$) was observed between the seed and pulp as well as the seed and core of *A. camansi*.

Copper (Cu) and manganese (Mn) showed the lowest contents in *A. camansi*. The Cu contents in the pulp, seed, and core of *A. camansi* were 2.23, 1.57 and 1.28 mg/100 g respectively. A lower value was reported by Adeleke and Abiodun (2010). The result revealed a significant difference ($p < 0.05$) between the pulp and core as well as the pulp and seed.

The Mn content of *A. camansi* was highest in the pulp (1.83 mg/100 g), followed by the seed (1.60 mg/100 g) and core 1.22 mg/100 g. The Mn content obtained by Adeleke and Abiodun (2010) is 1.20 mg/100 g in breadnut seed. The *A. camansi* core exhibited a significant difference ($p < 0.05$) in the Mn content between the pulp and seed.

Total phenolic content

The methanol extract of seed had the highest TPC (22.1 mg GAE/g seed), whereas the methanol extract of pulp had the lowest

Table 2. Mineral content of *Artocarpus camansi* (mg/100 g, wet basis)

	Zn	Fe	Ca	Cu	Na	Mn
Core	46.0 ± 5.66b	15.4 ± 0.07a	159 ± 2.40c	1.28 ± 0.12a	9.75 ± 2.24b	1.22 ± 0.12a
Pulp	44.0 ± 5.66b	20.6 ± 0.17b	151 ± 0.42b	2.23 ± 0.14b	13.6 ± 0.37b	1.83 ± 0.05b
Seed	28.5 ± 0.71a	15.8 ± 0.56a	126 ± 0.31a	1.57 ± 0.05a	4.50 ± 0.42a	1.60 ± 0.14b

Mean values ± standard deviation (n = 2)

Values with different letters are significantly different at $p < 0.05$

TPC (7.88 mg GAE/g pulp). The *A. camansi* core had a TPC of 9.73 mg GAE/g core in methanol extracts. A significant difference ($p < 0.05$) was observed between the seed and other fruit parts. The water extract of *A. camansi* seed had the highest TPC (5.22 mg GAE/g seed), followed by the core (2.35 mg GAE/g) and pulp (1.69 mg GAE/g pulp). The result revealed a significant difference ($p < 0.05$) in the TPC among the samples.

The TPC from methanol extracts (7.88 – 22.1 mg GAE/g sample) is higher than that from water extracts (1.69 – 5.22 mg GAE/g sample) because compounds in the plants are more soluble in methanol (Table 3). Abu Bakar et al. (2009) reported that the TPC of *A. camansi* seed is higher than that of *Artocarpus odoratissimus* seed, which only has 14.67 mg GAE/g seed. The isolation of lectin from *A. camansi* showed the medicinal properties of breadnut (Occeña et al. 2007). The presence of these compounds may contribute to the TPC in *A. camansi* seed, core and pulp.

DPPH scavenging activity

The DPPH inhibition of the samples extracted from methanol followed the order seed > pulp > core with the values of 90.4, 87.4 and 84.9% respectively (Table 3). Alothman et al. (2009) reported that the percentage of DPPH radical scavenging activity obtained from all parts of *A. camansi* is higher than that of guava and banana (pisang mas), which are 68.6% and 65.6% respectively. ANOVA test showed a significant difference ($p < 0.05$) among all of the samples.

The percentage of DPPH inhibition of *A. camansi* samples extracted from water followed the order seed > core > pulp with the values of 59.9, 45.2 and 39.5% respectively. Alothman et al. (2009) reported that the percentage of DPPH inhibition of pineapple and banana (pisang mas) extracted from water is 12.7% and 36.8% respectively. The values of the different parts of breadnut were higher than those of both samples. Moreover, a significant difference ($p < 0.05$) in DPPH radical inhibition was observed between all the samples. Methanol extract of *A. camansi* showed higher percentage of DPPH inhibition than water extract. Thus, different solvent systems will result in different extraction capabilities. Based on the study conducted by Brighente et al. (2007), the antioxidant effect on DPPH radical scavenging can be attributed to its hydrogen-donating ability.

Total antioxidant activity was measured as the cumulative capacity of the compounds present in the sample to scavenge free radicals by DPPH reaction (Magalhaes et al. 2006; Abu Bakar et al. 2009). According to Alothman et al. (2009), the DPPH radical scavenging assay is widely used to determine the antioxidant capacity of extracts from the different plant materials. In addition, the antioxidant activity of the extract assessed will be reflected by the percentage of inhibition DPPH radical within the assay time.

Brighente et al. (2007) stated that plant extracts are allowed to react with the stable radical DPPH in methanol solution, producing a deep purple colour. Disappearance of DPPH radical chromogens

Table 3. Total phenolic content and DPPH inhibition of *Artocarpus camansi* core, pulp and seed extract from methanol and water extraction

	TPPC (mg GAE/g)		DPPH (%)	
	Methanol	Water	Methanol	Water
Core	9.73 ± 0.28a	2.35 ± 0.25b	84.9 ± 1.62a	45.2 ± 1.23b
Pulp	7.88 ± 0.86a	1.69 ± 0.10a	87.4 ± 0.46b	39.5 ± 3.46a
Seed	22.1 ± 2.61b	5.22 ± 0.18c	90.4 ± 0.57c	59.9 ± 0.81c

Mean values ± standard deviation (n = 3)

Values with different letters are significantly different at $p < 0.05$

is caused by the presence of antioxidants in the sample (Abu Bakar et al. 2009). The reaction of antioxidant in the samples with the free radical DPPH converts it to 1,1-diphenyl-2-picrylhydrazine by donating hydrogen (Son and Lewis 2002).

Conclusion

The highest percentage inhibition of DPPH radical scavenging activity was observed in the methanolic extract of *A. camansi* seed, followed by pulp and core. The lowest scavenging activity was found in *A. camansi* pulp using water extraction. To encourage industrial adoption, further research on toxicity test and the incorporation of *A. camansi* fruit in processed food products, such as beverages, yoghurts, and flour for pastries, and evaluation of the microbial and sensorial qualities of such products are necessary.

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Abstrak

Kajian ini adalah untuk menentukan komposisi proksimat, mineral dan jumlah kandungan fenolik (JKF), serta kapasiti antioksidan empulur, isi dan biji buah kulur (*Artocarpus camansi*). Bagi komposisi proksimat, bahagian isi mengandungi kandungan abu (1.47%) dan kandungan protein (1.29%) yang tinggi, manakala bahagian empulur mengandungi kandungan lembapan yang tinggi (88.6%). Zat mineral dalam buah kulur ialah kalsium, zink, kuprum, mangan, besi dan natrium. Peratus perencatan DPPH adalah dalam turutan biji > isi > empulur. Nilai JKF sampel ialah 7.88 – 22.1 mg bersamaan asid galik (GAE)/g bagi ekstrak metanol dan 1.69 – 5.22 mg GAE/g ekstrak air. Penilaian memberikan asas yang kukuh bagi nilai pemakanan *A. camansi*, buah yang jarang digunakan. Keputusan menunjukkan buah kulur boleh dimakan meskipun jarang didapati, murah dan mengandungi nilai aktiviti antioksidan yang tinggi dan berpotensi untuk digunakan dalam industri makanan dan kesihatan.