

## Proximate analysis of *Artocarpus odoratissimus* (Tarap) in Brunei Darussalam

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### Abstract

*Artocarpus odoratissimus* samples obtained from three different locations in Brunei Darussalam were analysed for their proximate composition which consists of moisture, ash, total carbohydrate, crude protein, crude fibre, energy content and crude fat. The mineral and sugar (fructose, glucose and sucrose) were also investigated. *A. odoratissimus* flesh contained 67.9 – 73.4 g/100g moisture (wet basis), 0.6 – 0.8 g/100 g ash (wet basis), 12.0 – 25.2 g/100 g total carbohydrate (wet basis), 1.2 – 1.5 g/100g crude protein, 0.8 – 1.3 g/100g crude fibre (wet basis), 334 – 379 kcal/100g energy content (dry basis) and 85 – 363 mg/kg proline (wet basis). The seeds contain 31.0 - 55.0 g/100g moisture (wet basis), 1.0 – 1.5 g/100g ash (wet basis), 3.2 – 4.7 g/100g crude fibre (wet basis), 5.1 - 6.6 g/100g crude protein (wet basis), 10.1 – 28.1 g/100g crude fat (dry basis), 488– 497 Kcal/100g energy content (dry basis), 1.2 – 2.3 g/100g fresh weight of total carbohydrate and 255 – 476 mg/ kg proline. Mineral content (potassium, sodium, calcium, magnesium, copper, cobalt, nickel, zinc, manganese cadmium and lead) was determined and potassium was found to be the most abundant mineral in both the flesh and the seed. No lead was detected in any parts of the fruit. From the quantification of sugar content, fructose was the dominant type of sugar in *Artocarpus odoratissimus* flesh (5.8 – 13.7 g/100g). From the range of nutrients, *A. odoratissimus* is generally comparable with *A. heterophyllus*, *A. altilis* and *A. integer*.

### Keywords

*Artocarpus odoratissimus*  
proximate compositions  
sugar content  
mineral content

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### Introduction

The genus *Artocarpus* belongs to the *Moraceae* family which consists of 40 genera and 1400 species that are mainly distributed in the tropics and subtropics with a few species in the temperate regions (Anon, 1956). The genus *Artocarpus* consists of approximately 50 species of small to large evergreen trees and is native to South and South-east Asia. Examples of *Artocarpus* include *A. altilis* (Breadfruit), *A. integer* (Chempedak), *A. heterophyllus* (Jackfruit), *A. hypargyreus*, *A. lakoocha*, *A. kemando*, *A. hirsutus*, *A. chaplasha*, *A. odoratissimus* and etc. They are in the same family as the fig, *Ficus* species (Litz, 2004).

The genus *Artocarpus* has a long history of use in agriculture, industry and as a source of food, especially in Asia. For example, the fruit pulp of *Artocarpus heterophyllus* is sweet and tasty and used as a dessert or preserved in syrup. Immature green fruits are widely used as a vegetable. *Artocarpus*

*heterophyllus* seeds are eaten after boiling or roasting, or dried and salted as table nuts, or ground to make flour. On the other hand, the leaves are used as food wrappers in cooking whereas the flowers are used as food in salads or cooked as vegetables (Haq, 2006).

The synonyms of *Artocarpus odoratissimus* species are *Artocarpus tarap* Becc. and *Artocarpus mutabilis* Becc. The English name is Marang. The common name for *A. odoratissimus* varies from place to place: pingan (Iban), pi-ien (Bidayuh), keiran (Kelabit), terap (Malaysia), marang (Sulu), madang (Lanao), loloi (Tagalog), and khanun sampalor (Thailand) (Subhadrabandhu, 2001). *A. odoratissimus* is well known in Borneo. In Brunei Darussalam, *A. Odoratissimus* is locally known as “Tarap”. It is now being cultivated in the Philippines (Haq, 2006). It is also thought that the maximum diversity occurs in Brunei Darussalam as reported by Haq (2006).

The *A. odoratissimus* tree is evergreen and can grow up to 25 m tall and has a 40 cm diameter trunk with a low buttress. The twigs are 4-10 mm thick with

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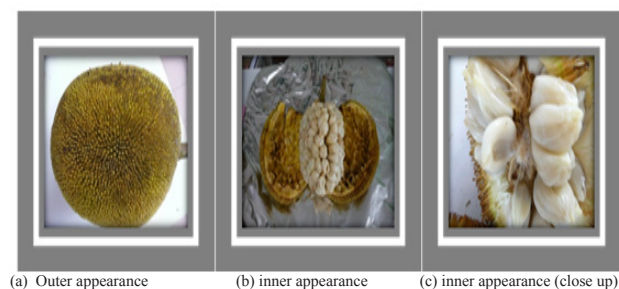


Figure 1. Outer and inner appearance of *Artocarpus odoratissimus*

long yellow to red hair. The fruit is large, averaging about 16 cm in length, 13 cm in diameter and weighs about 1 kg. The fruits are roundish oblong, regular and thickly studded with short, brittle, greenish yellow spines. The flesh is juicy and aromatic (Coronel, 1983). Galang (1955) described the flesh as clinging to the central core and each segment of the flesh contains a seed which has a size of 8 x 15 mm. Galang (1955) also reported the nutritional composition of *A. odoratissimus* in 1955 whereas Fadzelly *et al.* (2010) studied the cytotoxicity and polyphenol diversity in selected parts of *A. odoratissimus*.

The young fruits are relished as unique vegetables usually stewed with meat or cooked with spices and coconut milk. Since fresh vegetables are not readily available for the tribal people living in the interior of Borneo, the fruit forms the staple vegetable diet for them. The fruit is eaten raw and the seeds are also edible when boiled or roasted. The flesh is commonly mixed with flour and egg batter and fried as tarap fritters, used to flavour ice-cream, and can be fermented to organic vinegar. Studies on the nutritional composition of *A.odoratissimus* (Galang, 1955), the phytochemicals and antioxidant activity of different parts of *A.odoratissimus* (Bakar *et al.*, 2009) and the cytotoxicity and polyphenol diversity in selected parts of *A. odoratissimus* fruits (Fadzelly *et al.*, 2010) have been reported.

## Materials and Methods

### Samples preparation and storage

Seventeen fruits of *Artocarpus odoratissimus* (Tarap) were bought from the market located in Brunei Darussalam. The fruits were separated into the flesh, seed, core and skin respectively. However, only the edible portions of the fruits were analysed. The samples were extracted using the AOAC Official method 920.149 with slight modification (Cunniff, 1998). All fresh flesh and seed samples were blended for about 2 min with doubly distilled water (100 mL) at room temperature and gravity filtered. The filtrate was then stored in the freezer prior to analysis.

### Determination of moisture content

Whole (intact) *A. odoratissimus* seeds were dried at 45°C for seven weeks. *A. odoratissimus* flesh was dried using a freeze dryer. The dried seeds and flesh were transferred into sample bottles and kept in desiccator until further analysis.

### Determination of ash content

Fresh samples were placed in the GALLENKAMP muffle furnace and ignited to 600°C for about 4 to 6 h until residue has turned white. The ash was then used for the determination of mineral content.

### Determination of total carbohydrate

The phenol-sulfuric acid method (AOAC Method 44.1.30), as stated in the Food Analysis Laboratory Manual (Nielsen, 2003) with slight modifications, was used for the determination of the total carbohydrate content. A series of 6 calibration standard solutions was prepared from the glucose stock solution with the concentration ranging from 0 µg/2mL to 100 µg/2mL. The blended sample extracts (1 mL) prepared in Section 2.1 was further diluted in a 100 mL volumetric flask using doubly distilled water. This diluted sample (1.0 mL) was then transferred into a clean conical flask followed by the addition of doubly distilled water (1.0 mL). Analysis was done in duplicate. The 80 % phenol solution (50 µL) was added to each of the standards and sample solutions and swirled to mix well.

Concentrated sulfuric acid (5 mL) was carefully added at a constant rate. In order to obtain good and consistent mixing, the stream of acid was added directly to the solution mixture without touching the side of the flask. The solutions were then left to cool to room temperature. The absorbance of each of the solutions was then measured using a Shimadzu UV-1601PC UV spectrophotometer at wavelengths between 450-550 nm. The standard solution with 0 µg/2mL water was used as reference. The absorbance for each of the standard and sample solutions was recorded at 490 nm.

### Determination of mono- and disaccharides by high-performance liquid chromatography (HPLC)

The mono- and disaccharide content (glucose, fructose and sucrose) in the fresh *A. odoratissimus* flesh of each sample was determined using HPLC-RID.

### Determination of sucrose content

The mobile phase for the determination of the sucrose content was 75% acetonitrile (HPLC grade) and 25% ultra-pure water. Sucrose (2.0078 g) was dissolved in ultra-pure water (100 mL). A series of

5 calibration standard solutions was then prepared using this solution with concentrations of 0.002, 0.004, 0.006, 0.008 and 0.010 g/mL respectively. The standard solutions were injected into the HPLC system and the peak height at about 8.2 min on the chromatogram was used to plot the calibration curve. Glucose (6.4 min) and fructose peaks (6 min) were also detected but the two peaks overlapped each other. The blended sample solutions were directly injected into the HPLC system and the peak height for each sample solution at the same retention time in as sucrose was recorded.

#### *Determination of glucose and fructose content*

Due to the overlap of the fructose and glucose peaks when the acetonitrile: ultrapure water (3:1) mobile phase was used, a mobile phase of different composition was prepared. To enable the separation of fructose and glucose, the mobile phase was changed to acetonitrile: ultra-pure water (17:3). A stock solution containing fructose (1.4988 g) and glucose (1.5004 g) in a 100 mL was prepared. A series of 5 calibration standard solutions was then prepared with concentrations of 0.0015, 0.003, 0.0045, 0.006 and 0.0075 g/mL respectively. The standard solutions were then injected into the HPLC system and the peak heights at about 8.5 min and 10 min were used to plot the calibration curves for fructose and glucose content respectively. With this mobile phase, the sucrose peak appeared after 12 min. The blended sample solutions were directly injected into the HPLC system and the peak heights were recorded.

#### *Determination of protein*

Crude protein was determined using the block digestion method with a selenium catalyst and the resulting mixture was allowed to steam distill into boric acid (Kjeldahl Method) (Cunniff, 1998; Madamba, 2000; Nielsen, 2003). Protein content in both flesh and seed samples was determined using a GERHARDT automated digestion system and distillation system.

#### *Determination of crude fibre*

Crude fibre was determined by the Weende Method (Nielsen, 2003) using the principle that crude fibre is the loss on ignition of the dried residue remaining after digestion of the sample with 1.25% (w/v) sulfuric acid and 1.25% (w/v) sodium hydroxide solutions.

#### *Determination of proline*

The method is based on the original method of Ough (Ough, 1969) which was extracted from the paper by Bogdanov (Bogdanov). The blended

sample extract were used for the determination. The absorbances were measured using the Shimadzu UV-1601PC UV/VIS spectrophotometer at wavelengths between 400 and 800 nm. The absorbance at 510 nm was recorded for each of the tubes. The proline content was determined from the ratio of the sample solution and the proline standard solution at the wavelength of 510 nm.

#### *Determination of fat content and the fatty acid profile*

The fat contents in *A. odoratissimus* seed was determined using the Soxhlet Method (Nielsen, 2003). The seed were either ground or cut into four pieces. Dried *A. odoratissimus* seed (6.0 to 15.0 g) was placed into a preweighed cellulose extraction thimble and reweighed. n-Hexane (150 mL) was poured into a preweighed 500 mL round bottom flask containing some boiling chips. The soxhlet extraction was carried out for at least 6 hours. The n-hexane was then removed by rotary evaporator and the weight of the crude fat was determined.

The fatty acid content in *A. odoratissimus* seed was determined using the AOAC Official Method 969.33 (Cunniff, 1998) with a slight modification. 99.5% methanol was prepared by mixing absolute methanol (99.5 mL) and distilled water (0.5 mL). Methanolic sodium hydroxide was prepared by dissolving sodium hydroxide pellets (2.0834 g) in the 99.5% methanol. Methanolic sodium hydroxide (4 mL) was added to the total fat obtained in Section 2.10. and mixture was refluxed for 10 min. Boron trifluoride (5 mL) was then added to the flask and refluxed for an additional 2 min. Heptane (3 mL) was added slowly to the boiling mixture and the mixture was then cooled to room temperature. Saturated sodium chloride (25 mL) was added, resulting in the formation of two layers. The layers were separated and the top layer was taken and transferred to a clean preweighed sample vial. The vial was then reweighed. Anhydrous magnesium sulfate was added. The fatty-acid methyl ester (FAME) profile was analysed using a Shimadzu GCMS-QP 2010 gas chromatograph-mass spectrometer (GC-MS).

#### *Determination of energy*

The calorific content was determined using a GALLENKAMP Autobomb bomb calorimeter. Benzoic acid (about 1.2 g) was first combusted to determine the heat capacity of the calorimeter. This was then followed by the combustion of the dried sample (about 1.2 g).

#### *Determination of minerals*

The determination was carried out in duplicate. The ash obtained in Section 2.3 was dissolved in concentrated hydrochloric acid (2.5 mL) followed by concentrated nitric acid (2.5 mL). The mixture was then left at room temperature until all the ash had dissolved. Each replicate mixture was diluted to 50 mL using ultrapure water respectively. The solutions were kept in the refrigerator until further analysis using Shimadzu AA-6701F atomic absorption spectrometer.

## Result and Discussion

A total of seventeen samples of *A. odoratissimus* were analysed. These samples were bought from various markets throughout Brunei Darussalam i.e. the Brunei-Muara (n = 4), Temburong (n = 5) and Tutong Districts (n = 8). The fruit is made up of the skin, flesh, core and seed. The fruits were weighed before they were separated into the flesh, seed, core and skin respectively. Figure shows the outer and inner appearance of *A. odoratissimus*.

The fruit of *A. odoratissimus* is greenish yellow weighing about 0.5 - 1 kg depending on its size. It is roundish elliptical, regular and thickly studded with short, brittle, greenish yellow spines. The number of edible seeds varies greatly, averaging close to 100. The seed is ellipsoid about 1 cm x 0.8 cm. Figure 2 shows the percentage mass composition for each part of the fruit. The skin is the major part of the fruit followed by the flesh, core and the seed. No mass composition has been reported previously either for *A. odoratissimus* or the other *Artocarpus* species except for the edible portion. The edible portion of *A. odoratissimus* falls within the data reported by Galang (1955) (24 - 33%). The edible portion of jackfruit and chempedak (*A. heterophyllus* and *A. integer*) was reported by Morton (Morton,1987) to be 28% and 22% respectively. These three *Artocarpus* species have a similar mass composition for the edible portion, the flesh.

The moisture content of *A. odoratissimus* flesh was found to be between 67.9 to 73.4%. These values are within the range reported by Galang (1955) (65.7-84.2%) in 1955. In *A. odoratissimus* flesh, there was no observable trend that could be used to relate the moisture content with the size of the sample. The moisture content of *A. odoratissimus* seed was found to be in the range 31.1 to 54.5%. No previous value was found for the moisture content in the seed. The moisture content in jackfruit and chempedak flesh reported by Morton (Morton,1987) was 83 % and 67 %, while the moisture content of breadfruit as reported by Badrie (Badrie and Broomes, 2010) was

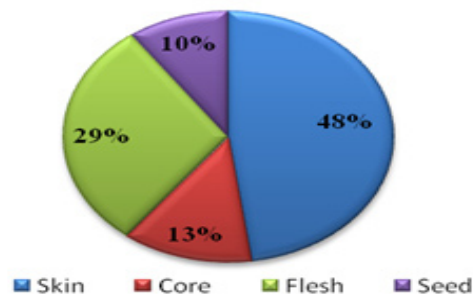


Figure 2. Mass composition of *A. odoratissimus*

Table 1. Minerals in *A. odoratissimus* flesh and seed

Mineral	Flesh (mg/100g)	Seed (mg/100g)
Potassium	176 - 298	352 - 443
Magnesium	15 - 31	103 - 132
Sodium	1.1 - 1.7	0.9 - 3.8
Calcium	0.5 - 1.4	1.5 - 3.0
Iron	0.3 - 0.5	0.8 - 1.2
Nickel	0.01 - 0.06	0.13 - 0.29
Cobalt	0.11 - 0.26	0.10 - 0.15
Manganese	0.02 - 0.93	0.27 - 8.64
Copper	0.39 - 0.67	0.58 - 0.83
Zinc	0.17 - 0.45	0.71 - 1.83
Cadmium	0.0104 - 0.0149	0.0125 - 0.0172

63.8 - 74.3%. Moreover, pedalai (*A. sericicarpus*) and selangking (*A. nitidus*) have 69.3% and 80.8% moisture content respectively (Voon and Kueh, 1999). Thus *A. odoratissimus* has similar moisture content to chempedak, breadfruit and pedalai.

Ash represents the total mineral content in foods. In 100 g of fresh *A. odoratissimus* flesh, and seed, the ash content ranges from 0.6 - 0.8 g and 1.0 - 1.5 g respectively. The values reported Galang (Galang, 1955) was 0.5 - 0.8 g per 100 g fresh sample. The flesh has less ash than the seed. The ash content in jackfruit and chempedak flesh reported by Morton (Morton,1987) was 2.2 % and 1.2, while pedalai and selangking have 1.7% and 0.7% ash content respectively (Voon and Kueh, 1999). *A. odoratissimus* has a similar ash content to selangking and a lower ash content the other *Artocarpus* species. This implies that *A. odoratissimus* has less minerals than jackfruit, chempedak and pedalai.

The total carbohydrate content in the flesh and seed ranged from 12.0 to 25.2 g/100g sample and 1.2 to 2.3 g/100g sample respectively. The carbohydrate content for the flesh was reported as 32.4% by Galang (1955). The value obtained experimentally is however lower than this. The flesh has dramatically more carbohydrates than the seeds. The values reported for jackfruit and chempedak by Morton (Morton,1987) were 25.4 and 25.8 g/100g fresh sample, while the carbohydrate content of breadfruit reported by Badrie (Badrie and Broomes, 2010) was 22.8 - 77.3 g/100g fresh sample. The carbohydrate contents of these *Artocarpus* species are similar to *A. odoratissimus*.

Table 2. Proximate composition in *A. odoratissimus* flesh together with values obtained from other *Artocarpus* species

Nutrient per 100 g	Tarap	Reported value (wet basis)					
		Tarap	Breadfruit	Jackfruit	Chempedak <sup>3</sup>	Pedalai	Selanking <sup>4</sup>
Moisture (%)	67.9 – 73.4	65.7 – 84.2	63.8 - 74.3	83	67	69.3	80.8
Ash (g)	0.6 – 0.8	0.5 – 0.8	-	2.2	1.2	1.7	0.7
Carbohydrate (g)	12.0 – 25.2	32.4	22.8 - 77.3	25.4	25.8	27.4	14.0
Protein (g)	1.31 – 1.51	0.8 – 1.5	0.7 - 3.8	1.8	2.5	1.7	1.7
Fibre (g)	0.90 – 1.13	0.6 – 0.77	-	5.6	3.4	0.5	1.2
Fat (g)	-	0.2 – 0.3	0.26 - 2.36	0.2	0.4	0.3	1.6
Energy (kcal)	90.7 – 100.6	63 - 122	-	301	490	119	77
K (mg/100g)	176 -298	-	352	292	246	322	164
Na (mg/100g)	1.15 – 1.70	-	7.1	48	25	-	-
Ca (mg/100g)	0.48 – 1.35	17	15.2 - 31.1	37	40	22	29
Mg (mg/100g)	14.8 – 31.3	-	-	-	-	25	12
Fe (mg/100g)	0.29 – 0.53	21	0.29-1.4	1.7	1.1	0.8	0.6
Mn (mg/100g)	0.02 – 0.93	-	-	-	-	1	3
Cu (mg/100g)	0.39 – 0.59	-	-	-	-	2.5	1.7
Zn (mg/100g)	0.17 – 0.45	-	-	-	-	7.4	2.3
Cd (mg/100g)	0.0104	-	-	-	-	-	-
	0.0149	-	-	-	-	-	-

Note: The experimental energy, protein, fibre have been converted to wet basis

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Badrie, N. & Broomes, J. (eds. Watson, R. R. & Preedy, V. R.) 491-505 (Academic Press, San Diego, 2010).

Morton, J. F. Fruits of Warm Climates (Miami, Florida).

Voon, B. H. & Kueh, H. S. The nutritional value of indigenous fruits and vegetables in Sarawak. Asia Pacific Clinical Nutrition Society 8, 24-31 (1999).

The fructose, glucose and sucrose contents in *A. odoratissimus* flesh ranged from 6.9 – 13.7 g/100g, 5.8 – 13.7 g/100g and 0.3 - 11.2 g/100g respectively. Among these three types of sugar, fructose is the dominant sugar. The degree of sweetness for fructose is 173.3 whereas glucose is 74.3 (Vieira, 1999). Hence the sweetness of the fruit is mainly due to the presence of fructose. The fructose, glucose and sucrose in jackfruit was determined by Chowdhury (Chowdhury *et al.*, 1997) as 4.53, 2.06 and 1.49 g/100g on a wet basis. Similar to *A. odoratissimus*, fructose is the major sugar presence in the flesh followed by glucose and sucrose.

The fibre content in the flesh and seed ranges from 2.8 to 4.2 g/100g and 5.5 to 10.0 g/100g. The fibre content in the flesh is somehow higher than that reported by Galang (Galang, 1955) (0.6 - 0.77%). The crude protein content in *A. odoratissimus* flesh and seed ranged between 1.2 – 1.5 and 5.1 – 6.6 g/100g respectively. The seeds contain more protein than the flesh. The protein content in the flesh is within the range reported by Galang (1955). The stage of maturity and the growing environment will affect the protein content. By considering the edible part of the fruit, the flesh and seed are good sources of protein. This conclusion is based on the acceptable macronutrient range obtained from the Dietary Reference Intakes (DRIs) (Trumbo, 2002) in which the acceptable range for children and adults is between 5 and 35 g/100g of sample.

The proline content of *A. odoratissimus* flesh and seed ranged from 84.9 – 256.3 mg/kg and 254.6

– 476.4 mg/kg (wet basis) respectively. The seed has more proline than the flesh for all the samples. No previous values on the proline content for *A. odoratissimus* were found. As stated by Ting and Rouseff (1979), the proline content is closely related to the maturity and cultivar of the fruit. Hence this may explain the large variation as the maturity of the fruit samples bought is not known.

The crude fat content in *A. odoratissimus* seed ranged from 10.1 – 28.1 g/100g expressed on a dry basis. The fatty acids identified in the seed are hexanoic acid, octanoic acid, hexadecanoic acid, octadecanoic acid and tetracosanoic acid. The major fatty acid component in the seed is hexadecanoic acid (palmitic acid) and the second most abundant is the octadecanoic acid (stearic acid). The characterization of the fatty acid in the seed is only based on the seven authentic FAMES that had been injected. Nevertheless, there are more peaks in the chromatogram that have not been characterized due to non-availability of authentic FAMES.

Table 1 shows the minerals content in *A. odoratissimus* flesh and seeds. Potassium is the major mineral in both parts of the fruits. The flesh has less potassium (176 – 298 mg/100g) compared to the seed (352 – 443 mg/100g). Meanwhile magnesium is the second most abundant mineral in both parts of the fruit whereby the seed has the highest magnesium content Among all the minerals analysed, sodium is the third most abundant mineral found in the flesh (1.1 – 1.7 mg/100g) and seed (0.9 – 3.8 mg/100g). The calcium content obtained (flesh 0.5 – 1.4 mg/100g,

seed 1.5 – 3.0 mg/100g) is lower than that reported by Galang (1955) (17 mg). Among all the trace minerals analysed, the cadmium content is the least. No lead was found in any of the samples.

#### *Comparison of the proximate composition between A. odoratissimus and other genera of Artocarpus*

The proximate composition of *A. odoratissimus* flesh together with the values obtained for different *Artocarpus* flesh such as *A. altilis* (breadfruit), *A. integer* (chempedak), *A. heterophyllus* (jackfruit), *A. sericarpus* (pedalai) and *A. nitidus* (selangking) is shown in Table 2. The moisture content in *A. odoratissimus* is within the range of the other *Artocarpus* species except for selangking and jackfruit. *A. odoratissimus* has the lowest ash content among all the other *Artocarpus* species. The total carbohydrate is within the range of all the other *Artocarpus* species. The crude protein and energy content are within the range stated by Galang (1955) while the crude fibre is slightly higher. The protein content in the other *Artocarpus* species are higher than *A. odoratissimus*. The crude protein in *A. odoratissimus* is higher than in pedalai but lower than the other *Artocarpus* species.

To the best of our knowledge, except for Ca and Fe, there have not been any reports on the mineral content of *Artocarpus odoratissimus*. Nevertheless, comparison of the mineral contents of *A. odoratissimus* with other *Artocarpus* species showed that the potassium and iron contents of *A. odoratissimus* are also within the range of the other *Artocarpus* species except for chempedak. The sodium, calcium, manganese, copper and zinc content in *A. odoratissimus* are somehow lower than the other *Artocarpus* (Pedalai and Selanking) but no comparison is possible with other *Artocarpus* species such as breadfruit, jackfruit and chempedak since these data have not been reported. By comparing *A. odoratissimus* and the other *Artocarpus* species, it can be deduced that *A. odoratissimus* is closely related to jackfruit, breadfruit and chempedak. This corresponds with the statement by Subhadrabandhu (2001) where *A. odoratissimus* is the relative of jackfruit and breadfruit.

#### **Conclusion**

All the species of the genus *Artocarpus* in term of in the nutritional value are found to be similar but with some exceptions. On comparing with Galang's (1955) results published in 1955, there is a big difference in the nutritional values of the fruit. The variation in the fruit size (maturity) will also affect some of the nutritional content. These differences

might also be due to seasonal variation, the growing environment or the maturity of the fruit. Among the three sugars analyzed, fructose is the dominant sugar. No lead was found in any parts of the fruit and the cadmium content in the fruit is within the safe level for consumption.

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