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Physicochemical Properties of Dietary Fibers from *Artocarpus camansi* Fruit

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Abstract. The objective of this work was to investigate the dietary fiber (DF) contents of *Artocorpus camansi* (breadnut) fruit and examine their physicochemical properties, such as water-holding capacity (WAC), oil-holding capacity (OHC) and water absorption capacity (WAC). This fruit flour contained of both water soluble fibers (SDF), such as pectin (1.95%) and gum (0.4%), and water insoluble fibers (IDF) (89.25%). The IDF content of this fruit was significantly high in respect to other DF sources. The WHC, OHC and WAC of IDF were 4.10, 2.60 and 4.0%, respectively. Moreover, the WHC, OHC and WHC of total dietary fibers (TDF) were 4.2, 4.3 and 4.6%, respectively. The results showed that the DF of fruit flour had good physicochemical properties. The findings suggested that there is a potential application of *A. camansi* of fruit as functional ingredients in the food industry.

1. Introduction

Dietary fibre (DF) is composed of a mixture of plant carbohydrate. It is categorized into two major groups, which are water soluble fibers (SDF), such as pectin and gum, oligosaccharides and some hemicelluloses, and water insoluble materials (IDF), such as cellulose, hemicellulose and lignin [1-4]. DF is found naturally in cereals, nuts, vegetables and fruits. DF has several interesting physical properties such as water and oil holding capacities, swelling capacity, increasing viscosity and/or gel formation. The capability of the DF to absorb the water is the important physiological effect of DF on human health. This swelling properties occur due to the presence of carbohydrates with free polar groups, interaction with hydrophilic links or retention within the matrix [5].

Each group of DF has different physiological effects on human. The IDF is correlated to both water absorption and intestinal regulation, whereas the SDF is related with the reduction of cholesterol in blood and the decrease of glucose absorption by the small intestine [6,7]. Generally, the SDF and IDF is useful in the prevention of cardiovascular disease and colon cancer, respectively. Many studies have reported that high-fiber consumption protects and cures against obesity, cardiovascular diseases, diabetes and some types of cancer [4]. Therefore, growing interest in searching for new sources of dietary fiber content with good physicochemical properties.

Artocorpus camansi (breadnut) is found throughout the tropics region which is native to New Guinea, Indonesia and Philippines. It belongs to Moraceae family. Trees grow to heights of 10–15 m. The spiny fruits is dull green to green yellow when ripe and have little pulp. Breadnut is usually grown for its nutritious seeds. The seeds from the mature fruits are high content in protein and relatively low in fat. The seeds are also a good source of minerals and niacin. They are usually boiled or roasted. The fruits are usually consumed as staple food. However, the information on the nutritious value of the fruits

is still limited. In Indonesia, the immature fruits, including the seeds, are thinly sliced and cooked as a vegetable. This work reports the dietary fiber contents and physicochemical properties of the *A. camansi* immature fruits in order to find new sources of dietary fiber.

2. Experimental

2.1. Materials and Instruments

The mature fruits were obtained from local market. The fruit was peeled and then spread in tray and dried in oven at 50-60°C for overnight. The dried fruit was powdered in a mechanical grinder and passed through a 150 mesh sieve. The dried sample powder then were stored in hermetic bags at room temperature (25°C). High Performance Liquid Chromatograph (HPLC-UV Vis) LC-10AD Shimadzu was used.

2.2. Free Fat Sample

Dried sample (10 g) was macerated with a mixture of 15 mL methanol and 45 mL chloroform for 2 h and then filtered. The solvent was removed using a rotary evaporator. This free fat sample was used to obtained pectin and IDF.

2.3. Pectin Isolation

The free fat sample (2 g) in 100 mL of 0.1 M buffer phosphate pH 7.5 was added 85.7 mg protease (0.7 unit/mg) and incubated overnight at 37°C. It was mixed thoroughly during this period. The mixture was then filtered. Distilled water (200 mL) was added to the residues and the mixture was acidified with HCl to pH 1.5-2. The mixture was placed in water bath at 80°C for 4 h and then filtered. The resulted filtrate was mixed with 95% ethanol in the ratio filtrate:ethanol = 1:4 and left for 1 h. The mixture was then centrifuged at 15,000 rpm for 22 mins. The supernatant was discarded and the pellet was then analysed by HPLC.

2.4. Gum Isolation

The dried sample (100 g) was dispersed in 2 L distilled water. The NaOH was added to the mixture to reach pH 9.4 and was heated to 45°C for 1 h. It was mixed thoroughly during this period. The mixture was then centrifuged at 5,000 rpm for 15 mins. The supernatant was acidified with HCl to pH 4.6. The mixture was then left at cold room for overnight and then centrifuged at 10,000 rpm for 15 mins. The NaOH was then added to the supernatant to pH 8.3 and the mixture was heated to boil until the volume of the mixture was reduced by one-half. The mixture was added with 96% ethanol until the volume of ethanol reached 40% of the mixture. The mixture was mixed thoroughly and left overnight. The mixture was centrifuged at 10,000 rpm for 10 mins. The supernatant was discarded and the pellet was then analysed by HPLC.

2.5. IDF Isolation

The free fat sample (2 g) in 100 mL of 0.1 M buffer phosphate pH 7.5 was added 85.7 mg protease (0.7 unit/mg) and incubated for 2 h at 37°C. The mixture was then placed at 25°C and added EDTA 2 g. The mixture was left for 1 h and then filtered. The residue was then dispersed in 0.1 M buffer acetate pH 4 and 15.4 mg pectinase (3 unit/mg) was added to the mixture. The mixture was then placed in water bath at 25°C for 2 h. It was mixed thoroughly during this period. The mixture was then filtered and the filtrate was the insoluble dietary fibers.

2.6. Characterization of DF

Water holding capacity (WHC) and oil holding capacity (OHC) were determined following published procedures with some modification [8-9]. About 0.02 g of each sample was placed in a centrifuge tube, followed by the addition of 0.1 mL of oil or distilled water. The tube was left for 1 min at room temperature (25°C) with agitation. Subsequently, the mixture was centrifuged at 3.000 rpm for 10 mins and the oil supernatant was decanted. The wet sample was weighed, dried overnight and weight again

to determine the water content. The OHC was expressed as g of oil held per g of sample, and WHC was quantified as g of water held per g of fibers. The water absorption capacity (WAC) was determined by comparing the mass of the wet sample and the dried sample.

3. Results and Discussion

3.1. Dietary Fiber Contents

In the preparation of dried samples, 25 of fruits with approximately 200 g of each fruit were used. The dried sample was obtained as 500 g of light brown powder. The SDF (such as pectin and gum) and IDF content of *A. camansi* fruits are shown in Table 1. Pectin are structural components of plant cell walls, whereas gums are found in secretory plant cells. They are highly water-soluble and have gelling ability. The gelling ability of pectin can reduce the rate of gastric emptying and alter small intestinal transit time [1,10].

The pectin and gum values of *A. camansi* fruit were 1.955 and 0.40%, respectively. The pectin value was relatively lower than that of pectin content of coconut residue which is 3.60-4.32% [11]. The IDF of some cereal derivatives, fruits and vegetables have been reported, such as for wheat bran (41.6%), barley bagasse (41.4%), oat bran (20.2%), pear (22.0%), orange (24.3%), peach (26.1), asparagus (38.6%) and artichoke (44.5) [8]. Gorinstein (2001) have reported the IDF content of apples (0.37-0.46%) and persimmons (0.66-0.87%) [12]. It is noted that the IDF content of *A. camansi* fruit, which was 89.25%, was significantly higher than the reported DF sources.

Although the SDF content for pectin and gum were relatively small, the IDF content of *A. camansi* fruit was high. The relatively high IDF content in *A. camansi* fruit recommends possible applications in dietetic–physiological products. Consumption of this fiber feasibly enhanced functioning of the digestive system and preventing disorders such as constipation and colon cancer.

Table 1. Dietary fibers content of *A. camansi* fruit

Dietary Fibers	Weight (%)
SDF	
- Pectin	1.95
- Gum	0.40
IDF	89.25

3.2. Characterization of DF

Table 2 shows the physicochemical properties of DF content of *A. camansi* fruit. The WHC represents the ability of the materials to retain water. Number of hydroxyl groups in the fiber structure allow water interaction through hydrogen bonding which caused water absorption. Water has important role on food changes during baking such as on gelatinization, denaturation, yeast and enzyme inactivation, flavor and color formation [12, 13]. The WHC is related to physiological role in intestinal function and blood sugar level control [8,14].

The WHC of the SDF from pectin and gum were lower than that of the IDF and TDF. The WHC of the IDF and TDF value were similar. The WHC values of IDF and TDF from *A. camansi* fruit were higher than that of for maize hull and (2.32 g/g) dan wheat hulls (2.48 g/g). However, they are lower than that of the soybean fiber (4.9 g/g), wheat bran (6.1 g/g) and shoyu mash residue (10.85 g/g). The results indicated that the WHC of IDF and TDF from the *A. camansi* fruit had comparable WHC of the reported DF sources. Vegetable fibers with high WHC have been added as meat product ingredients [8,15]. This finding suggested that the potential application of DF from *A. camansi* fruit in food products such as in functional bakery and meat products ingredients, in order to increase the dietary fiber intake.

The OHC of IDF and TDF from A. camansi fruit was 2.60 and 4.30 g/g, respectively. The OHC of the several DF sources have reported such as chia FRF. (2.02 g/g), jack bean (2.3 g/g) and barley (2 g/g) and the OHC of IDF from orange peel was 3.36 g oil/g sample. Particle size and the method used to isolate the fiber affect the OHC values [16]. In this case, the smaller the particles the more contact surface, as consequences, it could hold more oil [5]. It is possible to increase the OHC value of IDF

from A. camansi fruit by reduction of the particle size and isolation of DF with alcohol to expose the lipophilic components. Due to its relatively low in OHC value, the A. camansi fruit is a potential ingredient in fried products since it would create a non-greasy sensation.

Table 2. Physicochemical properties of DF from *A. camansi* fruit.

No	Physicochemical Properties	SDF		IDF	TDF
		Pectin (g/g)	Gum (g/g)	(g/g)	(g/g)
1.	Water-holding capacity	1.80±0.19	1.20±0.31	4.10±0.38	4.20±0.35
2.	Oil-holding capacity	2.10±0.59	2.40±0.40	2.60±0.42	4.30±0.48
3.	Water-absorption capacity	1.80±0.08	2.30±0.16	4.30±0.05	4.60±0.10

The WAC express the fiber structure ability to spontaneously absorb water when soaked in water or placed in contact with a constantly moist surface. Water absorption initially occurs at surface, however, it can lead to swell and event solubilize [17]. The WHC of IDF and TDF from *A. camansi* fruit were higher than that of wheat hulls (2.91 g/g) carrot (0.82 g water/g sample), beet (1.58 g water/g sample) and soybean fiber (1.42 g/g). However, it was lower than that of chia FRF (11.73 g/g). The relatively high value of WAC probably due to the protein of the *A. camansi* fruit may be denaturalized by the solvent and heat treatment during defatting. A large number of exposed hydrophilic sites occurred and then interacted with water and increased the WAC. However, denaturalization would also expose hydrophobic sites and thus favor protein–protein interaction that would reduce WAC [8, 18]. In this case, the balanced of hydrophilic and hydrophobic sites might be exposed which gave relatively high value in WAC.

4. Conclusion

Overall, it could be concluded that *A. camansi* fruit had high IDF content. The WHC, OHC and WAC were relatively high and comparable with other known DF sources. This work approves that DF obtained from *A. camansi* fruit have great potential in food application, especially in development of functional foods.

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