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Keluwih (*Artocarpus camansi Blanco*): Potential utilization as foodstuff and its bioactivity

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Abstract

Artocarpus camansi (AC) has been long used by Indonesian local people as food and traditional medicine. This study aims to explain the relationship between the use of AC as a food ingredient and traditional medicine and its bioactivity. The method used in writing this article is a literature study on various scientific articles published online at Google Scholar using AC, uses AC, and AC bioactivities. The results obtained were synthesized so as to be able to explain the botany, utilization and bioactivity of AC in a comprehensive manner. The fruits of AC have been used as a vegetable ingredient, baby food and has the potential to be developed as an economic commodity. The use of AC as a food ingredient is related to its nutritional content. The seeds of AC are rich in protein carbohydrates, amino acids, fats and minerals (phosphorus, potassium, sodium, iron, copper). As a traditional medicine, AC is used to treat dysentery, malaria, related to its bioactivity as an anti-microbial, anti-malarial, anti-diabetic-mellitus, anti-cancer. The flavonoids of AC extract associated with antimalarial and anti-cancer activity, while -sitosterol propionate was associated with anti-diabetes mellitus activity. AC is very potential to be developed as an alternative food ingredient as well as anti-diabetes mellitus.

Keywords: *Artocarpus camansi*; Diabetes Mellitus; Flavonoid; Sitosterol

1. Introduction

Williams et al [1] stated that Moraceae is a family of Magnoliophyta that is widely used by humans both as food and traditional medicine. The jackfruit (*Artocarpus heterophyllus*), breadfruit (*A. altilis*), *cempedak* (*A. integer*) and breadnut (*A. camansi* = AC) are species of Moraceae that have been long used by local Indonesian as food [2]. Mohammed & Wickham [3] reported that AC qualifies as a commodity with its unique taste, high fiber content, high percentage of complex carbohydrates and the ability to be utilized in a variety of ways.

The fruit AC used as a vegetable but its utilization is decreasing due to diminishing sources of supply. Empirically, it can be seen that in Jakarta and its surroundings, AC is also used as a shade because it has a shady canopy and large leaves so it is easy to clean. The use of AC as a food ingredient is related to the nutritional content such as carbohydrates, proteins, fats and minerals. AC seeds contain phosphorus, potassium, sodium, iron, copper [4], but are affected by processing [5] and storage. The water content, crude protein and ash of fermented AC beans were higher than that of raw beans, while the levels of fat, fiber, carbohydrates, vitamins A and C were higher in raw beans [5]. The fruits of AC is very perishable with a shelf life of no more than two days under environmental conditions [3].

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Besides being used as food, AC is also used as traditional medicine. In traditional medicine, AC is used to treat dysentery [6], malaria [7,8], cancer [9] and diabetes mellitus [10,11,12,13]. The use of AC as a traditional medicine is related to its secondary metabolite content. Flavonoids from AC have activity as antimalarials while β-sitosterol propionate has activity as anti-diabetes mellitus [10].

Roberts-Nkrumah & Legall [14] stated that AC is a plant species that has the potential to be developed for food security and increasing income. On the other hand, the demand for AC is increasing while the supply or its existence is decreasing. The use of AC as food and traditional medicine is less familiar when compared to jackfruit, breadfruit and *cempedak*, so an in-depth study of its use and bioactivity is needed.

2. Methods

The method used in writing this article is a literature study on various scientific articles published online at Google Scholar. Some of the keywords used are: *Artocarpus camansi*, uses AC, and AC bioactivities. The results obtained were synthesized so as to be able to explain the botany, utilization and bioactivity of AC in a comprehensive manner.

3. Results and discussion

3.1. Botany of Artocarpus camansi Blanco

Artocarpus J. R. Forst. & G. Forst. (Moraceae) contains ap-proximately 70 species of monoecious trees with a center of diversity in Malesia [15]. Southeast Asia is one of the centers of Moraceae diversity [3] including Indonesia. The 70 species of Moraceae [15], about 50 species are indigenous to Southeast Asia and the Pacific islands [3]. AC has started to be cultivated in Indonesia, Malaysia, the Caribbean Islands, the Pacific Islands, tropical Central and South America, and coastal West Africa [16]. All members of the genus Artocarpus have fleshy infructescence's (syncarps), which develop from inflorescences of thousands of tiny flowers that are tightly packed and compacted into their receptacles [1].

Description: AC is a tree with a height of up to 10-15 m and a diameter of up to 1m and more, often growing up to 5 m before having branches. It has a very sticky white milky latex that comes from all parts of the plant. The diameter of the canopy generally reaches half of its height. Is a plant with a single stem with a evergreen canopy (Fig. 1A). Trees have buttresses at the base of the trunk.

Figure 1 Breadnut (*Artocarpus camansi* Blaco). A. Branches that support the leaves. B. Fruits traded in the market

The leaves are alternate arrangement, measuring 40-60 cm in length with 4-6 lobes and sinuses up to half of the midrib (Fig. 1A). New leaves on young trees can reach 76 cm in length. They are densely pubescent with white or reddish-white hairs on the upper and lower surface of the veins and petiole. Blade is dull green with green veins. It has two stipules attached to the bud which then turn yellow before falling off. Plants are monoecies with male and female flowers on the

same plant located at the ends of the branches and female flowers appearing first. Male flowers are clustered and up to 3 cm in diameter and 25-35 cm in length. Thousands of tiny flowers with two anthers attached to the center of the spongy core.

The female inflorescence consists of 1500-2000 reduced flowers attached to a spongy core. Unlike bread-fruits, the individual flowers do not fuse together along their length. The fruit is a large fleshy syncarp, oval to ovoid in shape with a length of 15-20 cm and a diameter of 7-13 cm and weighs about 800 g (Fig 1B). The skin is dull green to green yellow when ripe with a spiny from the pointes, flexible with a length of 5-12 mm at the end of each flower. The scanty pulp is yellow-whitish when ripe with a sweet aroma and taste. The fruits is not as solid a dense as bread fruit because the individual flowers forming the fruits are fused together only at their based.

AC reproduces by seed with varying number of seeds and sizes and nutrients. The fruit contains seeds from 12-150 per fruit with a weight of about 7-10 grams and about 30-50% of the total weight of the fruit. The seed are rounded or flattened by compression and about 2-5 cm long. They have a thin, light-brown outer seed coat that is patterned with darker veins. The seed have little or no endosperm, no period dormancy, germinate immediately and are unable to withstand. Typically spread by flying foxes and arboreal mammals [17].

3.2. The Foodstuff

The food plants are plants that have nutrients. In Indonesia, empirically it can be seen that the potential plant species developed as alternative food ingredients are very diverse [18], but their supply and utilization tend to decrease due to the degradation of local knowledge [19]. *Keluwih* or breadnut which in Latin is known as AC qualifies as a commodity with a unique taste, high fiber content, high percentage of complex carbohydrates and the ability to be utilized in various ways [3]. The *A. camansi* as one of the plant species that has the potential to be developed for food security, increasing income and increasing demand [14]. The breadnut is also used as animal feed, a source of latex and wood [14]. AC also has potential in international trade. Each AC fruit has 50 to 100 nut-like seeds embedded in a white pulp. This fruit is highly perishable with a shelf life of no more than two days under environmental conditions [3].

The proximate composition of AC seeds contained protein (4.87%), fat (3.48%) and carbohydrates (26.11%), ash and crude fiber 3.43 and 1.20%, respectively. AC seeds are also rich in minerals phosphorus (363 mg/kg), potassium (325 mg/kg) and sodium 248 (mg/kg), iron (0.05 mg/kg) and copper (0.12 mg/kg). The amino acids in AC seeds are leucine (392 mg/kg, phenylalanine (312 mg/kg), arginine (293 mg/kg), isoleucine (245 mg/kg) and lysine (275 mg/kg). .4%, oleic 12.4% and linolenic acid 14.8%. The lactic and citric acid are the predominant organic acids while malic, acetic and butyric acids are present in small amounts.AC seeds can be used as composite flour and oil can be good source of vegetable oil for human consumption [4].

The nutritional content of AC seeds is also influenced by the processing process. Fermentation and boiling increase the nutritional profile of AC [5], therefore processing is one of the important things to maintain its nutritional value. The water content, crude protein and ash in fermented AC beans) were higher than the raw ones, while the levels of fat, fiber, carbohydrates, vitamins A and C were higher in raw beans. Calcium, Phosphorus, and Zinc content was significantly higher in boiling while magnesium and iron were significantly higher in fermented. The essential amino acids, leucine, lysine, alanine, histidine, tyrosine, phenylalanine were significantly higher in fermentation while other amino acids were higher in boiled [5]. Fermented AC seeds can be used as a condiment for soups because they contain beneficial microorganisms that increase the nutritional value of food and help reduce food-borne disease microbes that can be harmful to health [20]. Nelson-Quartey et al [21] stated that AC fruit can also be developed as baby food by combining breadfruit and breadnut seeds, corn seeds and peanuts and stated that the protein and fat content of these foods comparable to commercial baby food.

3.3. Uses and Bioactivity

3.3.1. Anti-Diabetes Mellitus

Diabetes mellitus is a syndrome of carbohydrate metabolism disorders characterized by chronic hyperglycemia [13,22] due to insufficient insulin secretion [13] which is directly and indirectly related to α-amylase [23] and often lead to complications of hyperlipidemia [22]. It is estimated that there will be 360 million people with diabetes mellitus worldwide in 2030 and is expected to continue to increase [13]. This has resulted in the exploration of natural ingredients to treat diabetes mellitus, including AC. The use of AC as anti-diabetic mellitus has been reported by Marianne et al [12], Nasution [10], Nasution et al [11], Eryuda and Soleha [13], Nasution et al [24], Permata & Asben [23] and Warin -wind [22].

Diabetic rats (injected with streptozotocin 55 mg/kg bw) were then given AC leaf water extract (50, 100, 200, 400 mg/kg bw) for 14 days orally to reduce cholesterol, triglycerides, low density lipoprotein, very low-density lipoprotein, and increasing high density lipoprotein at a dose of 100 mg/kg bw significantly so as to prevent complications from diabetes mellitus [22] (Perangin-angin 2020). The ability of AC leaf ethanol extract to reduce blood glucose levels at concentrations of 50 and 100 mg/kg bw was better than the doses of 200 and 400 mg/kg bw [12]. The ability of AC leaf extract to inhibit -amylase was different, namely young leaves, mature leaves and old leaves respectively 1888.83 g/ml, 2353.84 g/ml, and 3199.35 g/ml [23].

The bioactivity of AC as anti-diabetes mellitus is related to its secondary metabolites. The fraction of AC bark hexane extract had -sitosterol lower blood sugar levels in mice [11] and better than glibenclamide (a commercial drug) [24], but its activity was lower than pure -sitosterol [10]. The leaves of AC contain flavonoids which are thought to play a role in regenerating damaged pancreatic cells so that insulin deficiency can be overcome [13]. The flavonoid of AC leaf is artocarpine which is thought to have a hypoglycemic effect [13].

3.3.2. Anti-microbial

Pathogenic microbes cause various infectious diseases, especially in the digestive tract such as *Shigella dysenteriae* and *Bacillus subtilis* [6]. Exploration of natural ingredients as anti-microbial continues to be carried out, because bacterial resistance to antibiotics is increasing. Antimicrobial compounds are compounds that can inhibit the growth or cause death of microbes. The use of AC as an antimicrobial has been reported such as Ante et al [25], Amelia [6] (2020) and Noah and Ogunfowote [20].

The AC extract inhibited the growth of *Escherichia coli, Shigella flexenari, Salmonella typhi,* and clinical isolates of *Pseudomonas aeruginosa* [25], *S. dysenteriae* and *Bacillus subtilis* [6]. The inhibitory power of AC extract fights bacteria by punching holes in the bacterial cell membrane, leading to the release of nucleic acids and proteins and cell death [6]. The volatile composition of leaf oil, bark and seeds of AC varies so that their bioactivity also varies. The ability of leaf, stem bark and seed extracts to inhibit drug-resistant *E. coli, S. flexenari, S. typhi*, and clinical isolates of *P. aeruginosa* is related to the volatile oil content [25]. The ability of AC extract to inhibit the growth of bacteria varied depending on the compounds used in the extraction, the organ and the characteristics of the bacteria. The leaf AC extract has an inhibitory power against MIC (minimum inhibitory concentration) value of 25% against *S. dysenteriae* and 6.25% against *B. subtilis* [6].

The volatile oil content of leaves (m-xylene, myristaldehyde, phytol, ethyl benzene, bark (m-xylene, o-xylene, ethyl benzene) and seeds (lanosteryl acetate, olean-12-en-3y acetate, 24-methylene cycloartenol, m-xylene, and squalene. Although the leaves, stems and seeds contain m-xylene, the levels in the stems are higher (61.32%) than in the leaves (36.82%) and seeds (15.26%). AC showed low activity against *S. flexenari, S. aureus*, drug-resistant *P. aeruginosa* and moderate activity against *S. typhi*. The bark volatile oil showed low activity against *P. aeruginosa* but moderately active against *E. coli* and *S. typhi* while seeds showed low significant activity [25].

3.3.3. Anti-malaria

Until now malaria is a tropical disease that is difficult to control. The malaria parasite, Plasmodium, has been reported to be resistant to commonly used antimalarial drugs, such as chloroquine [26]. Plants of the Artocarpus genus are known to have high flavonoid content which has bioactivity as anti-malarial [26]. Crude extracts of leaves and bark of *Artocarpus* sp have antimalarial activity in vitro and in vivo [7, 26]. The triterpenoid fraction of AC leaf methanol extract had antimalarial activity of *Plasmodium berghei* with the most effective dose of 100 mg/kg BW for three days with the time of administration after the mice were infected with malaria [8]. The methanol extract of AC wood stem and root bark inhibited the growth of *P. falciparum* with IC50 values of 1.84 g/mL and 32.13 g/mL, respectively [26].

3.3.4. Anti-cancer

The bark AC bark activity against human colon cancer cell line (HCT116), breast cancer cell line (MCF-7), lung adenocarcinoma cell line (A549) and Chinese hamster ovarian cell line (AA8) by assay using 3- (4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide (MTT) assay [9]. Compounds obtained from AC dichloromethane extract, namely leaves (squalene, b-sitosterol, stigmasterol, and phytol) and stems (polyphenol) showed cytotoxic activity in human cancer cells: lung adenocarcinoma cells A549, AGS stomach adenocarcinoma cells, colon HT29 adenocarcinoma cells and PC3 cells. Prostate cancer [27].

4. Conclusion

The *Artocarpus camansi* fruit is used as a vegetable ingredient, baby food and has the potential to be developed as an economic commodity. The use of *A. camansi* as a food ingredient is related to its nutritional content. The seeds *A. camansi* are rich in protein carbohydrates, amino acids, fats and minerals (phosphorus, potassium, sodium, iron, copper). As a traditional medicine, *A. camansi* is used to treat dysentery, malaria, related to its bioactivity as an anti-microbial, anti-malarial, anti-diabetic-mellitus, anti-cancer. The *A. camansi* flavonoids were associated with antimalarial and anti-cancer activity, while -sitosterol propionate was associated with anti-diabetes mellitus activity.

Compliance with ethical standards

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