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EFFECT OF PRE-TREATMENT ON NUTRIENT, ANTINUTRIENT, AND ANTIOXIDANT PROPERTIES OF DRIED SHOOTS FROM SOME EDIBLE INDONESIAN BAMBOO SPECIES

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ABSTRACT

Abundant bamboo species are scattered throughout the world, some of which grow in tropical and sub-tropical regions, including Indonesia. Some species of bamboo are edible, and the part that is commonly consumed is the shoot. In several countries around the world, bamboo shoots are a traditional food with the potential to grow into a functional food. It contains antioxidants and is rich in minerals and dietary fiber. Antioxidants are heat sensitive components, so to extend the shelf-life and maintain antioxidant content, it is necessary to examine the drying method using a low temperature. Besides nutrients, bamboo shoots also contain a lethal concentration of the anti-nutrient cyanogen that needs to be removed before human consumption. Preliminary treatment is needed to reduce cyanide in dried bamboo shoots to be safe for consumption. The aim of this study was to determine the effect of pre-treatment on nutrient, anti-nutrient, and antioxidant properties of fresh-cut and dried edible Indonesian bamboo shoot species. *Gigantochloa pseudoarundinacea* (local name '*bambu gombong*'), *Dendrocalamus asper* (local name '*bambu betung*'), *Gigantochloa apus* (local name '*bambu buluh*'), and *Bambusa vulgaris var. striata* (local name '*bambu kuning*') were selected for the study. The pre-treatment consisted of steaming and boiling with salt for 10 minutes and 20 minutes, respectively. Total phenolics, total flavonoid, toxicity, and free radical scavenging activity of dried bamboo shoots were studied using Folin-Ciocalteu, aluminium chloride, brine shrimp lethality (BSLT), and 2,2-diphenyl 1-picrylhydrazyl (DPPH) scavenging assays. The results showed that pre-treatment methods and type of bamboo shoots significantly affected the yields, nutrient composition, minerals, and antioxidant properties of dried bamboo shoots ($P<0.05$), except for moisture content and the level of cyanide ($P>0.05$). In the pre-treatment process, cyanide levels in dried bamboo shoots decreased about 78-97% from fresh-cut shoot. It is concluded that the pre-treatment by steaming for 10 minutes is suitable for bamboo shoot processing because it produced maximum values of yields, nutrient content, and retention of antioxidant properties.

Key words: Antioxidant, anti-nutrient, cyanide, dried shoots, Indonesia bamboo species, minerals, toxicity

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INTRODUCTION

There are 1250 species of bamboo scattered throughout the world, some of which grow in tropical and sub-tropical regions [1]. Indonesia has 161 bamboo species, and 60 of these are from Java Island [2].

Some species of bamboo are edible, and the part that is commonly consumed is the shoot. Bamboo shoots are young stems of bamboo with a length of about 20-30 cm above the ground [3]. Some edible species in India are *Dendrocalamus (D.) strictus* and *Bambusa (B.) bambos*, *B. nutans, B. tulda, D. giganteus,* and *D. hamiltonii* [4]. Among several species, *D. asper* is the most commonly consumed and cultivated in Thailand [5]. The main source of edible bamboo shoot species in Japan is *Phyllostachys (P.) pubescens* [6]; the main species of edible bamboo shoots in Taiwan are *P. edulis* and *D. latifera* [7]. In Indonesia, some of the bamboo species usually used for edible purposes include *D. asper* (*bambu betung*), *Gigantchloa (G.) apus* (*bambu tali/buluh*), *G. atroviolacea* (*bambu wulung*), *G. atter* (*bambu ater*), *G. pseudoarundinacea* (*bambu gombong), B. vulgaris* (*bambu ampel*), and *B. vulgaris* var. *striata* (*bambu gading/kuning*).

Similar to several countries around the world, bamboo shoots have become a traditional food in Indonesia, included as vegetables by sauteeing (most of the region), cooked as curry (Sumatera region), fermented with a local name '*lemea'* (Bengkulu-Sumatera), pickled with the local name 'asinan' (West Java), and made into snacks with the local name '*Lumpia*' (Central Java), chips, and vinegar. Fresh bamboo shoots have a yellowish beige colour, distinctive fresh aroma, soft and crisp texture, and delicious taste [8]. Bamboo shoots are also a healthy vegetable because of the rich contents of amino acids and antioxidants [9]. Comparisons of nutritional values of various species of bamboo shoots have been studied and reported by several researchers. However, the information on nutritional value of edible bamboo shoot species in Indonesia is very limited. Therefore, it is necessary to compare the nutritional value of local bamboo shoots in Indonesia. It is suspected that there are differences from previous reports due to growing places and agro-ecological areas.

Besides nutrients, bamboo shoots also contain a lethal concentration of the anti-nutrient cyanogen that needs to be removed before human consumption. The acute lethal dose of cyanide for human consumption is 10 mg HCN/kg body weight [10]. Different bamboo species have different cyanide levels [11], which can be reduced through several processes such as steaming[7], repeated pre-soaking with 2% salt solution [12], boiling in water and different concentrations of NaCl [4], high temperature steaming at 116^{o}C [13], and fermentation [14]. Each method provides different effects among bamboo species.

Generally, after harvesting, bamboo shoots still experience biological activity because of the high water content (88-92%). Thus, a process is needed to reduce the water content of bamboo shoots to extend its shelf-life without reducing the nutritive value. Research on bamboo shoot drying methods has been reported by several researchers, such as using a cabinet dryer at 60^{o}C for 7-8 hours [15], hot air drying methods [16], two-stage drying:

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hot airflow drying followed by vacuum freeze drying, and a reverse of the process-vacuum freeze drying followed by hot air flow drying [17].

Bamboo shoots have the potential to become a functional food because of high contents of antioxidants they contain and are rich in dietary fiber. Antioxidants are heat sensitive, so to extend the shelf-life and maintain the antioxidant content, it is necessary to examine the drying method using low temperatures. In addition, preliminary treatment is needed to reduce cyanide in dried bamboo shoots to be safe for consumption. The aim of this study was to determine the effect of pre-treatment on nutrient, antinutrient, and antioxidant properties of dried shoots from some edible Indonesian bamboo species.

MATERIALS AND METHODS

Reagents and materials

Quercetin, gallic acid, 1,1-diphenyl 2-picrylhydrazyl (DPPH), and Folin-Ciocalteau's phenol reagent were purchased from Sigma-Aldrich (Singapore); aluminium chloride, n-hexane, sodium hydroxide, HCl, sulfuric acid, ethanol, and sodium carbonate were purchased from Merck; *Artemia salina* L. larva (Hobby Artemix) was purchased from Dohse Aquaristik GmbH & CO. Gelsdorf, Germany. All the reagents were of analytical grade.

Fresh-cut bamboo shoots were collected from Rawalele Village (6º32'11.4"S 107º 43'29.5E) and Dawuan Kaler Village (6º32'37.1"S 107º 41'34.0E), Dawuan District Subang-West Java, Indonesia, from January to June 2018. The four species of bamboo shoots used in the research are *D. asper* (*bambu betung*), *G. apus* (*bambu buluh*), *B. vulgaris* var. *striata* (*bambu kuning*), and *G. pseudoarundinacea* (*bambu gombong*). Botanical authentication was performed by botanist "Herbarium Bogoriense", Research Center for Biology, Indonesian Institute of Sciences (No. 957/IPH.1.01/If.07/IV/2018).

Research design and sample preparation

The study used a factorial randomized design with 2 factors, bamboo shoot species (4 levels) and pre-treatment method (4 levels) and each treatment was repeated 3 times. The pre-treatment method used two previous research methods, in other words, boiling in 1% NaCl solution and steaming at two different times (10 and 20 minutes), to compare the value of nutrients, antioxidants, and cyanide. The sample preparation process included peeling, washing, slicing, pre-treatment, draining, and drying using a cabinet dryer at 45ºC for 26 hours. Dried bamboo shoots were packed and stored at room temperature until analysis.

Procedure analysis

Physicochemical properties

Physicochemical properties, *viz*. yields using moisture content were determined by direct heating (oven); ash by muffle furnace; protein by DuMaster protein analyzer (Du Master D-480, Buchi, Switzerland); lipid by Soxhlet method; crude fiber by gravimetric methods; and carbohydrate by Luff schrool method [18].

Minerals (atomic absorption spectroscopy)

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The digestion and minerals analysis of dried bamboo shoots were described by Piper [19]. The sample was accurately weighed (0.5 g), put into glass beakers, then HNO_3 (20 mL), $HClO_4$ (5 mL), and H_2O_2 (1 mL) were added. After that, the samples were cooled at room temperature, and de-ionized water (50 mL) was added. Standards of minerals or stock solutions (1000 mg/L) each of Na, K, Ca, Mg, Fe, and Zn (Sigma-Aldrich, Singapore) were used for atomic absorption spectroscopy (AAS) analysis (GBC 933 AA, Australia). The calibration standard of each element was prepared by serial dilution. Samples were analysed in triplicates.

The levels of cyanide

Levels of cyanide were determined as described by Bradbury *et al.* [20]. Dried bamboo shoots were accurately weighed (5 g), placed in a test tube, chloroform (1 mL) added, and covered with picrate paper. Dried bamboo shoots extract or cyanide standard solutions (1 mL) were added with distilled water (1 mL), and HCl solution (1 mL, 3 N), then covered with installed picrate paper, and left for 3 hours at 25ºC. The picrate filter paper was removed and eluted in 10 mL distilled water. The absorbance of each eluate was measured by spectrophotometer (Shimadzu 1800 UV-Vis, Japan) at λ= 490 nm against blank. The calculation of cyanide levels was obtained using the following equation (1):

$$\text{Levels of cyanide} = Y \times 1000 \qquad (1)$$

Where:
Y = μg cyanide on a standard curve

Toxicity

The toxicity of dried bamboo shoots was determined by brine shrimp lethality (BSLT) method [21]. Ten active nauplii, brine shrimp eggs (Hobby Artemix®, Germany) in seawater were drawn through a glass capillary and placed in each vial containing brine solution (4.5 mL) for 48 hour. Samples (0.5 mL) were added with brine solution (4.5 mL) and left for 24 hours at room temperature under light, and then dead and live larva were counted. The experiments were conducted along with control (vehicle treated), different concentrations of the test substances in a set of three tubes per dosage and reported as LC_{50}. LC_{50} was the concentration required to kill larvae up to 50% in the specified time period.

Total phenolics content

Total phenolics content of dried bamboo shoots was determined by the Folin-Ciocalteau method with modifications [22]. One hundred microliter of samples or blank or gallic acid standard solutions were added with distilled water (2.8 mL) and sodium carbonate (2 mL, 2%), and left for 4 minutes in the dark. An amount of 100 μL Folin-Ciocalteu was added into the solutions, and left for 30 minutes in the dark. Measurement was conducted on a spectrophotometer (Shimadzu 1800 UV-Vis, Japan) at λ= 760 nm against the blank. Total phenolics content were expressed as mg gallic acid equivalent (GAE) in gram of dry weight of plant. Samples were analysed in triplicates.

Total flavonoids content

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Aluminium chloride assay was used to determine the total flavonoids content of dried bamboo shoots [23]. One mL samples or blank or quercetin standard solution were added with aluminium chloride (2 mL, 2% in methanolic solution), then mixed and left standing for 30 minutes in the dark. Measurement of total flavonoids content was conducted using a spectrophotometer at λ= 415 nm against the blank. Total flavonoids content were expressed as mg quercetin equivalent (QE) in gram of dry weight of plant. Samples were analysed in triplicates.

Antioxidant activity

Antioxidant activity of dried bamboo shoots was determined by DPPH assay described by Kumaran and Karunakaran [24]. Sample solution of varying concentrations or blank or gallic acid standard solution (1 mL) was added with DPPH (3 mL, 0.004% in methanolic solution), and left for 30 minutes in the dark. Measurement was conducted on a spectrophotometer at λ= 517 nm against a blank. Data reported as the concentration of samples required to inhibit 50% of DPPH radicals in the specified period (IC_{50}). Samples were analysed in triplicates.

$$\%\text{Radical scavenging} = \left[\frac{(Ac-As)}{Ac}\right] \times 100 \qquad (2)$$

Where:
Ac= absorbance control or blank,
As= absorbance with sample or standard

Statistical analysis

Data were tested for normality and presented as mean ± standard deviation. The differences between treatments were analysed using ANOVA. Significant differences between mean values were determined using Duncan's Multiple Range Test (α=5%). All statistical analysis was performed using Microsoft Excel 2013.

RESULTS AND DISCUSSION

The nutritional content of fresh-cut bamboo shoots

The nutritional contents of fresh-cut bamboo shoots are shown in Table 1. The moisture content ranged between 91 – 93%, which agrees with Satya *et al.* [6] who reported 90.70%. According to Nirmala *et al.* [25], *G. apus* contained fat and carbohydrates at 0.8% and 4.9%, respectively. Carbohydrate was lower in this analysis (3.71%). Results for *B. vulgaris* and *D. asper* are in agreement with Sood *et al.* [26] who reported carbohydrate content of fresh *B. vulgaris* and *D. asper* as 3.4% and 2.9%, respectively.

According to Jone and Rice [27], the difference in parts of plant and portions of the same species influenced the cyanide content. Bamboo shoots contain toxic compounds called cyanogenic-glycosides. The results of cyanide content showed that the fresh-cut of some edible Indonesian bamboo shoots species ranged from 327 to 454 ppm (Table 1). Based on FAO/WHO Codex Alimentarius, a safe limit for human consumption of cyanide is 10 mg HCN equivalent per kg dry weight [10].

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The yields of dried bamboo shoots

The yield of dried bamboo shoots ranged from 4.73 to 5.84% (Table 2) and was significantly affected by the pre-treatment method and species (*P<0.05*). Species *D. asper* and *G.pseudoaundinacea* produced higher yields compared to *G. apus* and *B. vulgaris var. striata* (*P<0.05*). The steaming method produced higher yields of dried bamboo shoots than boiling in 1% NaCl solution method (*P<0.05*). The steaming method for 10 minutes had the highest yield compared to other pre-treatment methods and the boiling in 1% NaCl solution method for 20 minutes had the lowest yield. The boiling methods produced softer bamboo shoots than steaming. It is possible that direct contact with water causes more open tissue pores so that more dissolved solids are lost.

The nutritional content of dried bamboo shoots

The moisture content of the dried bamboo shoots ranged between 4.89 ± 1.89 -7.68 ± 2.02 % (Table 3), and was not influenced by the pre-treatment method species (*P>0.05*). Table 3 shows that the ash content of the dried bamboo shoots ranged between 7.43 ± 0.29 and 16.78 ± 1.34 %. Pre-treatment methods and species affected the ash content of dried bamboo shoots (*P<0.05*). Boiling in 1% NaCl solution method resulted in the highest ash content compared to steaming method (*P<0.05*). Dried *G. apus* shoots had the highest ash content followed by *B. vulgaris var. striata, D. asper,* and *G. pseudoaundinacea*.

The lipid content of the dried bamboo shoots ranged from 3.12 ± 1.64 to 7.40 ± 0.49 % (Table 3). Pre-treatment methods and species affected the ash content (*P<0.05*). Boiling in 1% NaCl solution method resulted in the highest fat content than steaming (*P<0.05*). In the steaming method, time significantly affected the fat content of dried bamboo shoots, at 20 minutes it had the lowest fat content than steaming at 10 minutes (*P<0.05*). Dried *B. vulgaris var. striata* had the highest fat content followed by *G. apus, D. asper,* and *G. pseudoaundinacea* (*P<0.05*). These results are in agreement with Zang *et al.* [9] that reported that the fat content of *Phyllostachys praecox* shoots was reduced by boiling and steaming.

Table 3 also shows that the protein content of the dried bamboo shoots ranged between 19.28 ± 1.87 and 30.37 ± 3.79 %. Pre-treatment methods and species affected the ash content of dried bamboo shoots (*P<0.05*). The steaming method resulted in the higher protein content than boiling in 1% NaCl solution method (*P<0.05*). However, the pre-treatment time of cooking had no significant effect on the protein content of dried bamboo shoots (*P>0.05*). The dried *G. apus* shoots had the highest protein content (*P<0.05*). Crude proteins and lipid content in all pre-treatment methods decreased because of the reaction of proteins and fat to heat treatment. The results are in agreement with Nirmala *et al.* [14] that reported that boiling pre-treatment of dried shoots can decrease 25 % of protein and amino acids due to denaturation. Proteins and fat will be denatured and oxidized if they react with heat [28], and may be degraded into free amino acids and free fatty acids [29]. The cooking methods were found to adversely affect the protein content of bamboo shoots [4].

The carbohydrates of the dried shoots ranged from 44.75 ± 1.17 to 62.12 ± 3.38 %. Pre-treatment methods and species affected the crude carbohydrate content (*P<0.05*). The

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steaming method resulted in higher crude carbohydrate than boiling in 1% NaCl solution method (*P<0.05*). In the steaming method, time significantly affected the carbohydrate content of dried bamboo shoots (*P<0.05*); however, in the boiling method, time had no effect on the carbohydrate content. Carbohydrate content increased with steaming time. Species *D. asper* and *G. pseudoaundinacea* produced higher carbohydrates compared to *G. apus* and *B. vulgaris var. striata* (P <0.05). According to Zang *et al.* [9], heat treatment caused a decrease in carbohydrates and protein content. This is indicated by a change in colour in bamboo shoots due to the Maillard reaction.

Mineral composition
The minerals are described in Table 4. Potassium was the highest mineral component in the dried bamboo shoots (6.81 ± 0.69 - 44.72 ± 1.78 mg/1000 g). Mineral composition of dried bamboo shoots was not significantly affected by species (*P>0.05*), except for sodium and zinc content, which showed significant values in several species (*P<0.05*). *G. apus* had the highest sodium content compared to *B. vulgaris* var. *striata*, *D. asper,* and *G. pseudoaundinacea.* Dried shoots of *D. asper* contained lower zinc than *G. apus, B. vulgaris* var. *striata*, and *G. pseudoaundinacea.* Mineral composition was significantly affected with pre-treatment method (*P<0.05*), whereas calcium and iron were not affected (*P>0.05*). The potassium concentration significantly decreased while sodium and zinc significantly increased in the boiling 1% NaCl solution method (*P<0.05*). The nutrient content decreased with increasing treatment temperature. These results are in agreement with Pandey and Ojha [11] that reported different treatments would give different responses to nutrients in bamboo shoots. The total mineral content was reduced by boiling [4]. Generally, the bamboo shoots have relatively higher content of potassium and magnesium and it may have therapeutic values.

The anti-nutrient content of dried bamboo shoots
The anti-nutrients are described in Table 5. The species and parts of bamboo shoots determine the levels of cyanide. The level of cyanide of fresh and dried bamboo shoots was significantly affected by species (*P<0.05*).

The level of cyanide content of fresh shoots ranged from 327.44 to 454.52 mg/1000 g. After the pre-treatment process, cyanide levels in dried bamboo shoots decreased by 78-97% from fresh-cut shoot. However, the difference in the pre-treatment method did not significantly affect the dried shoot cyanide levels (*P>0.05*). Pandey and Ojha [4] reported that the best treatment for removal of anti-nutrient would be a method to retain nutrients with maximum reduction of cyanogens. However, in this case, the steaming method for 20 minutes in *G. pseudoarundinacea, D. asper,* and *G. apus* species had the highest decrease in cyanide levels, (342.212 - 436.560 mg/1000 g loss). Meanwhile, species of *B. vulgaris* var. *striata* had a decrease in the highest cyanide level at the pre-treatment boiling at 1% NaCl method at 20 minutes (315.02 mg/1000 g loss).

The toxicity
Taxiphyliin are cyanogenic compounds that are found in bamboo shoots, so to consume them, a further process is needed to eliminate the bitter taste that it produces [30]. The toxicity (LC_{50}) brine shrimp lethality tests are summarized in Table 6. The dried bamboo shoots tested showed non-toxic activity for steaming pre-treatment methods (LC_{50} value

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more than 1000 µg/mL), except *G. apus, D. asper,* and *B. vulgaris* var. *striata* dried shoots for 10 minutes steaming (LC_{50}<1000 µg/mL). Meanwhile, all the dried bamboo shoots with boiling pre-treatment methods showed toxic activity (LC_{50}<1000 µg/mL). Table 6 also shows that the tendency of cooking time in the pre-treatment method increased the LC_{50} value of dried bamboo shoot. According to Rao [31], variations in temperature during the process may affect LC_{50} values. This may be due to the denaturation of some bioactive compounds and other reasons that may only be active when the shoots are fresh.

Total phenolics, total flavonoids content, and antioxidant activity

In South East Asia, bamboo is used as anti-free radical, antioxidant, anti-aging and anti-cancer [3] product. The results of total phenolics, total flavonoids content, and antioxidant activity of dried shoots are displayed in Table 7. Total phenolics content of dried shoots for steaming and boiling pre-treatment methods ranged from 8.44 – 27.83 mg GAE/100 g and 0.10 – 0.33 mg GAE/100g, respectively. The difference in the pre-treatment method significantly affected the total phenolics content (*P<0.05).* Steaming pre-treatment with a time of 10 minutes had the highest total phenolics content compared to the pre-treatment boiling method. *G. apus* and *B. vulgaris* var. *striata* contained the highest level of total phenolics content followed by *G. pseudoarundinacea* > *D. asper*. According to Badwik *et al.* [32], the maximum loss of phenolic content (from 101.65 mg/100 g to 39.34 mg/100 g) at 95ºC for 30 minutes blanching and the highest retention of phenolic content (from 101.65 mg/100 g to 59.57 mg/100 g) at 75ºC for 5 minutes blanching. High intensity heat treatment leads to the maximum loss of phenolic content, which may be due to thermal degradation, leaching or diffusion of component into water [33].

One of the phenolic groups with antioxidant properties is flavonoids. Table 7 shows the amount of total flavonoids content of dried bamboo shoots for steaming and boiling pre-treatment methods ranging from 0.92 – 2.49 QE/100g and 1.49 – 1.62 mg QE/100g, respectively. The flavonoids content was significantly affected by the pre-treatment method (*P<0.05).* The total flavonoids content tended to decrease when there is an increase in cooking time, both for steaming and boiling methods. *D. asper* contained the highest total flavonoids content followed by *B. vulgaris* var. *striata* > *G. pseudoarundinacea* > *G. apus (P<0.05).*

Antioxidant activities of dried bamboo shoots were evaluated by DPPH radical assay. Table 7 shows that the pre-treatment methods and species significantly affected the antioxidant activities (*P<0.05*). *B. vulgaris* var. *striata* and *G. apus* contained the highest levels of antioxidant activities followed by *G. pseudoarundinacea* > *D. asper* (Table 7).

CONCLUSIONS

The results show that pre-treatment methods and type of species of bamboo shoots significantly affected the yields, nutrient content, minerals, and antioxidant properties of dried bamboo shoots, except for moisture content and the cyanide level. In the pre-treatment process, cyanide levels in dried bamboo shoots decreased by about 78-97% from fresh-cut shoot. The steaming pre-treatment method with a time of 10 minutes had the highest total phenolics, total flavonoids and antioxidant activity compared to the boiling method. *G. apus* and *B. vulgaris* var. *striata* contained the highest level of total phenolics content and antioxidant activity followed by *G. pseudoarundinacea* > *D. asper*. Meanwhile, *D. asper* contained the highest total flavonoid content followed by the others. It can be concluded that 10 minutes steaming pre-treatment is suitable for bamboo shoot processing because it resulted in maximum nutrient levels and the retention of antioxidant properties.

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Authors' contributions
RK, ACI, LR and DAD designed and conducted field research; IF, RK, and LR performed laboratory analysis; RK, ACI, and DAD conducted statistical analyses; RK, LR and ACI wrote the manuscript with inputs from all co-authors; ACI had final responsibility for content. All authors read and approved the final manuscript.

Conflict of Interest
There is no conflict of interest in this paper.

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Table 1: The nutrient content of fresh-cut edible Indonesian bamboo shoots species per 100 g

Nutrient	Species			
	G. pseudoarundinacea	*D. asper*	*G. apus*	*B. vulgaris* var. *striata*
Moisture content (%)	91.16±0.10	93.17±0.07	92.17±0.15	91.75±0.13
Fat (%)	0.44±0.06	0.64±0.002	0.81±0.11	0.96±0.004
Protein (%)	2.78±0.97	2.67±0.23	2.36±0.01	2.65±0.12
Carbohydrates (%)	4.37±1.01	2.51±0.21	3.71±0.31	3.56±0.13
Ash (%)	1.25±0.08	1.01±0.09	0.95±0.02	1.08±0.12
Energy (kcal)	32.56±0.36	26.48±0.08	31.57±0.14	33.48±0.02
Cyanide acid (ppm)	454.52±53,42	360.97±8.96	451.40±63.50	327.44±14.45

Data were mean values ± SD

Table 2: The yields of some edible Indonesian dried bamboo shoots species

Species	Pre-treatment			
	Steaming		Boiling (at 1% NaCl+water)	
	10'	20'	10'	20'
G. pseudoarundinacea	5.84^{Aa}	5.52^{Aa}	5.43^{Ab}	5.20^{Ac}
D. asper	5.77^{Aa}	5.54^{Aa}	5.55^{Ab}	5.23^{Ac}
G.apus	5.60^{Ba}	5.71^{Ba}	4.89^{Bb}	4.73^{Bc}
B. vulgaris var. *striata*	5.46^{ABa}	5.48^{ABa}	5.25^{ABb}	5.05^{ABc}

Mean value with different alphabet in the same row and the same column are significantly different (*P<0.05*)

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Table 3: The nutrient content of some edible Indonesian dried bamboo shoots species per 100 g

Macro Nutrients (g/100 g)	Species	Pre-treatment			
		Steaming		Boiling (at 1% NaCl+water)	
		10'	20'	10'	20'
Moisture	*G. pseudoarundinacea*	4.89^{Aa}	6.47^{Aa}	6.56^{Aa}	7.36^{Aa}
	D. asper	5.87^{Aa}	6.12^{Aa}	7.68^{Aa}	7.55^{Aa}
	G. apus	5.38^{Aa}	5.98^{Aa}	6.38^{Aa}	5.78^{Aa}
	B. vulgaris var. *striata*	5.19^{Aa}	5.53^{Aa}	7.01^{Aa}	7.22^{Aa}
Ash	*G. pseudoarundinacea*	7.72^{Aa}	7.54^{Aa}	14.98^{Ab}	15.74^{Ac}
	D. asper	8.00^{Aa}	7.43^{Aa}	14.18^{Ab}	15.97^{Ac}
	G. apus	8.36^{Ba}	7.90^{Ba}	15.96^{Bb}	16.78^{Bc}
	B. vulgaris var. *striata*	7.95^{ABa}	7.74^{ABa}	14.87^{ABb}	16.16^{ABc}
Fat	*G. pseudoarundinacea*	6.05^{ABa}	2.96^{ABb}	6.57^{ABc}	6.42^{ABc}
	D. asper	4.45^{ABa}	3.42^{ABb}	6.26^{ABc}	7.20^{ABc}
	G. apus	3.17^{Aa}	3.12^{Ab}	7.40^{Ac}	6.89^{Ac}
	B. vulgaris var. *striata*	5.62^{Ba}	4.83^{Bb}	7.00^{Bc}	7.05^{Bc}
Protein	*G. pseudoarundinacea*	21.98^{Aa}	20.88^{Aa}	24.57^{Ab}	23.66^{Ab}
	D. asper	21.34^{Ba}	20.91^{Ba}	19.28^{Bb}	19.21^{Bb}
	G. apus	30.37^{Ca}	29.62^{Ca}	25.51^{Cb}	24.95^{Cb}
	B. vulgaris var. *striata*	29.56^{Ca}	29.04^{Ca}	22.91^{Cb}	22.35^{Cb}
Carbohydrates	*G. pseudoarundinacea*	59.36^{Aa}	60.79^{Ab}	47.32^{Ac}	46.83^{Ac}
	D. asper	60.34^{Ba}	62.12^{Bb}	52.60^{Bc}	50.08^{Bc}
	G.apus	52.72^{Ca}	53.38^{Cb}	44.75^{Cc}	45.61^{Cc}
	B. vulgaris var. *striata*	51.68^{Ca}	51.89^{Cb}	48.20^{Cc}	47.22^{Cc}

Mean values with different alphabets in the same row and the same column are significantly different ($P<0.05$)

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Table 4: The minerals content of some edible Indonesian dried bamboo shoots species

Minerals (mg/1000 g)	Species	Pre-treatment			
		Steaming		Boiling (at 1% NaCl+water)	
		10'	20'	10'	20'
Potassium	*G. pseudoarundinacea*	42.394^{Aa}	41.720^{Aa}	11.800^{Ab}	9.601^{Ab}
	D. asper	41.509^{Aa}	43.234^{Aa}	9.725^{Ab}	7.997^{Ab}
	G. apus	44.245^{Aa}	36.781^{Aa}	9.683^{Ab}	6.813^{Ab}
	B. vulgaris var. *striata*	44.720^{Aa}	44.285^{Aa}	10.891^{Ab}	8.576^{Ab}
Sodium	*G. pseudoarundinacea*	0.044^{Aa}	0.048^{Aa}	35.687^{Ab}	37.463^{Ab}
	D. asper	0.049^{ABa}	0.054^{ABa}	38.924^{ABb}	40.483^{ABb}
	G. apus	0.051^{Ba}	0.055^{Ba}	42.216^{Bb}	42.152^{Bb}
	B. vulgaris var. *striata*	0.055^{Aa}	0.047^{Aa}	34.208^{Ab}	39.226^{Ab}
Ferrum	*G. pseudoarundinacea*	0.042^{Aa}	0.040^{Aa}	0.053^{Aa}	0.054^{Aa}
	D. asper	0.044^{Aa}	0.047^{Aa}	0.052^{Aa}	0.060^{Aa}
	G. apus	0.050^{Aa}	0.056^{Aa}	0.057^{Aa}	0.040^{Aa}
	B. vulgaris var. *striata*	0.056^{Aa}	0.059^{Aa}	0.057^{Aa}	0.058^{Aa}
Calcium (ppm)	*G. pseudoarundinacea*	0.020^{Aa}	0.020^{Aa}	0.069^{Aa}	0.053^{Aa}
	D. asper	0.026^{Aa}	0.025^{Aa}	0.059^{Aa}	0.066^{Aa}
	G. apus	0.026^{Aa}	0.033^{Aa}	0.056^{Aa}	0.054^{Aa}
	B. vulgaris var. *striata*	0.033^{Aa}	0.049^{Aa}	0.074^{Aa}	0.058^{Aa}
Zinc (ppm)	*G. pseudoarundinacea*	0.017^{Aa}	0.016^{Aa}	0.017^{Ab}	0.015^{Ab}
	D. asper	0.016^{Ba}	0.015^{Ba}	0.013^{Bb}	0.013^{Bb}
	G. apus	0.017^{Aa}	0.017^{Aa}	0.015^{Ab}	0.017^{Ab}
	B. vulgaris var. *striata*	0.016^{Aa}	0.017^{Aa}	0.015^{Ab}	0.014^{Ab}

Mean values with different alphabets in the same row and the same column are significantly different (*P<0.05*)

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Table 5: The cyanide levels of some edible Indonesian dried bamboo shoots species

Species	Pre-treatment	Cyanogenes (mg/1000 g)	Loss mg/1000 g	Loss %
G. pseudoarundinacea	Raw	454.516		
	Steaming, 10'	27.963^{ABa}	426.553	94
	Steaming, 20'	18.307^{ABa}	436.209	96
	Boiling (at 1% NaCl+water), 10'	51.025^{ABa}	403.491	89
	Boiling (at 1% NaCl+water), 20'	32.414^{ABa}	422.102	93
D. asper	Raw	360.965		
	Steaming, 10'	80.434^{Ba}	280.531	78
	Steaming, 20'	18.753^{Ba}	342.212	95
	Boiling (at 1% NaCl+water), 10'	39.467^{Ba}	321.498	89
	Boiling (at 1% NaCl+water), 20'	28.506^{Ba}	332.459	92
G. apus	Raw	451.402		
	Steaming, 10'	27.766^{ABa}	423.636	94
	Steaming, 20'	14.842^{ABa}	436.560	97
	Boiling (at 1% NaCl+water), 10'	27.327^{ABa}	424.075	94
	Boiling (at 1% NaCl+water), 20'	19.812^{ABa}	431.591	96
B. vulgaris var. *striata*	Raw	327.438		
	Steaming, 10'	26.189^{Aa}	301.249	92
	Steaming, 20'	19.180^{Aa}	308.257	94
	Boiling (at 1% NaCl+water), 10'	14.844^{Aa}	312.594	95
	Boiling (at 1% NaCl+water), 20'	12.418^{Aa}	315.020	96

Mean values with different alphabets in the same row and the same column are significantly different ($P<0.05$)

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Table 6: Toxicity of some edible Indonesian dried bamboo shoots species

Species	LC_{50} (µg/mL)			
	Steaming		Boiling (at 1% NaCl+water)	
	10'	20'	10'	20'
G. pseudoarundinacea	1259.31	1052.90	474.65	698.30
D. asper	600.84	2569.06	577.57	594.34
G. apus	659.55	1065.10	444.81	782.09
B. vulgaris var. *striata*	321.55	1078.91	416.23	609.85

Data were mean values.

Table 7: Total phenolics, total flavonoids and antioxidant activities of dried bamboo shoot

Parameter	Species	Pre-treatment			
		Steaming		Boiling (at 1% NaCl+water)	
		10’	20’	10’	20’
Total phenolic content (mg GAE/100 g)	*G. pseudoarundinacea*	16.47^{ABa}	19.99^{ABa}	0.20^{ABb}	0.22^{ABb}
	D. asper	14.62^{Aa}	8.44^{Aa}	0.18^{Ab}	0.10^{Ab}
	G. apus	27.83^{Ba}	22.70^{Ba}	0.33^{Bb}	0.27^{Bb}
	B. vulgaris var. *striata*	26.96^{Ba}	18.69^{Ba}	0.32^{Bb}	0.22^{Bb}
Total flavonoid content (mg QE/100 g)	*G. pseudoarundinacea*	1.11^{Aa}	0.95^{Ab}	1.51^{Aa}	1.49^{Aa}
	D. asper	2.49^{Ba}	1.30^{Bb}	1.62^{Ba}	1.52^{Ba}
	G. apus	0.92^{Aa}	1.12^{Ab}	1.49^{Aa}	1.51^{Aa}
	B. vulgaris var. *striata*	1.11^{Aa}	1.07^{Ab}	1.51^{Aa}	1.50^{Aa}
Antioxidant activity (IC_{50}; µg/mL)	*G. pseudoarundinacea*	1378.46	1286.86	805.74	504.18
	D. asper	2489.60	1740.95	948.82	518.36
	G. apus	418.48	518.39	602.77	551.86
	B. vulgaris var. *striata*	347.48	831.57	497.25	872.17

Mean values with different alphabets in the same row and the same column are significantly different (*P<0.05*)

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