



(RESEARCH ARTICLE)



## Diversity of alternative food plants traded in the Kranggan Mas Traditional Market, Bekasi District, West Java Province, Indonesia

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### Abstract

The market is the main place for buying and selling alternative food plants and its rich in local wisdom. This study aims to explain the diversity of alternative food plant that are traded in the traditional market of Kranggan Mas, Bekasi District and their potential as healthy food ingredients. The research was conducted with an ethnobotanical approach with surveys, interviews and participations observation. The respondents were all traders who traded alternative food plants. The data was qualitative analysis includes grouping plants based on benefits, families, and parts used. A total of 12 species belonging 10 genera and 8 families of plants as alternative food are traded in the Kranggan Mas traditional market. A total of 7 species of food are available every day and 4 species are available seasonally. The part of used are tuber (82%) and fruits (18%). *Dioscorea alata* and *Artocarpus altilis* are foodstuff ingredients that are still very potential to be developed and cultivated because both species are easy to find in the surrounding environment and its uses as shade and living fence. The *Dioscorea alata* has compounds dioscorine which has activity to reduce hypertension, so that its recommended for postmenopausal women.

**Keywords:** Alternative food plants; *Artocarpus altilis*; *Dioscorea alata*

### 1. Introduction

The plants are the main ingredients used by humans to meet their nutritional needs. Plants that are used as a source of nutrients are called food plants. Anggraeni [1] states that food plants are grouped into staple foods, substitutes for staple foods (alternative foods), vegetables, fruits, cooking spices, and ritual foods. Staple food is the main food as a source of carbohydrates or as a source of energy. Indonesian local people use rice (*Oriza sativa*) as the main source of carbohydrates even though various other carbohydrate sources or alternative food ingredients are easily found in the surrounding environment [2,3].

The market is the main place used by the community as a place for buying and selling various food needs [4]. Iskandar et al [5] stated that traditional markets in West Java are rich in local wisdom regarding the use of plants including alternative food ingredients. The ideal food composition consists of 57-68% carbohydrates, 10-15% protein, and 20-30% fat, therefore diversification of carbohydrate sources needs to be done so that food sources can be preserved. Grubber and Partohardjono [6] stated that the cultivation of plants as staple foods such as rice (*Oriza sativa*), corn (*Zea mays*), and wheat (*Triticum aestivum*) has been practiced for a long time, since 8000 years ago. Although many types of plants produce carbohydrates, empirically there is exclusivity to certain foodstuffs, especially rice. This has a direct impact on the decline in public interest in other foodstuffs which results in a decrease in the diversity of food ingredients

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in the surrounding environment. Pawera et al [7] states that there is a decline in the interest of the younger generation to use food ingredients derived from wild plants due to changes in lifestyle, reduced availability, and limited knowledge of their nutritional value.

For people who live in urban areas, the market is the main source of obtaining food ingredients, both traditional markets and modern markets. Franco et al. [4] found that the biodiversity of plants traded in traditional markets was higher than in modern markets. de Albuquerque et al. [8] stated that the market is a public space where various kinds of products are sold, as well as a place for exchanging cultural information. This shows that the market is suitable to be used as a place for research on the diversity of food plants with their utilization or related to ethnobotany.

Ethnobotanical research on the use of plants as food is still limited. Iskandar et al [5] reported that as many as 10 plant species of carbohydrate sources were traded in the traditional market of Ujung Berung, West Java Province. The diversity of plants traded in traditional markets is thought to be influenced by local wisdom and traditions of local communities in the surrounding environment [9]. This relates to the market as a place for exchanging information on local knowledge between traders and other traders, between the community and traders, as well as between the community and other communities [4,9]. This study aims to explain alternative food ingredients as a source of carbohydrates.

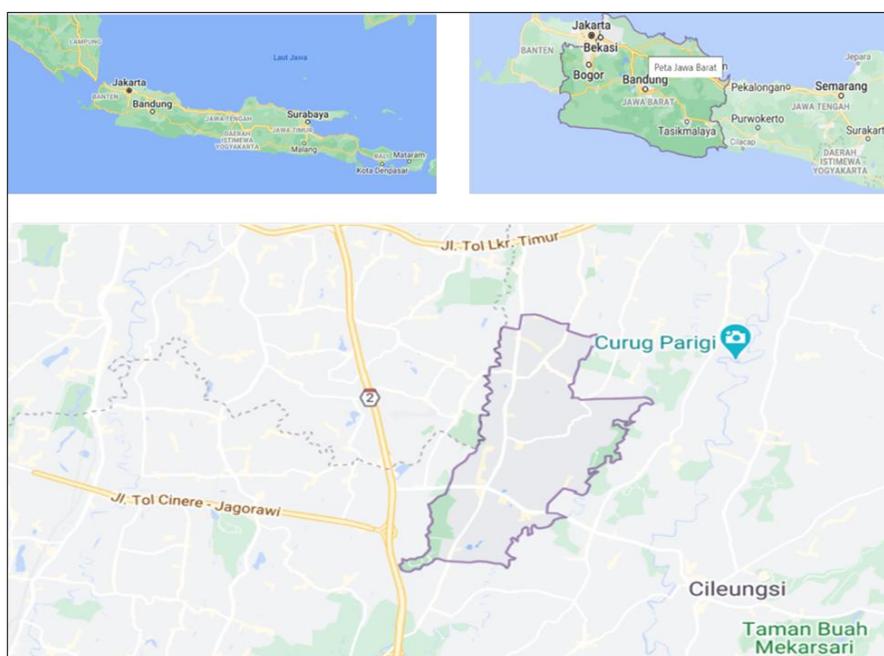
## 2. Methods

### 2.1. Research Site

This research was conducted at the Kranggan Mas traditional market, Bekasi District, West Java Province, Indonesia. Administratively, the Kranggan Mas traditional market is located in the Bekasi District, West Java Province (Figure 1). The study was conducted with an ethnobotanical approach with surveys, interviews and observations with modifications Silalahi et al [9].

Respondents in the study were all traders who traded alternative food ingredients. To facilitate communication, most of the ingredients used for sour vegetable ingredients were purchased by researchers. Some of the things that were asked of the respondents were the main ingredients (local name, part used), spices (local name) and processing methods. All data obtained were documented by photographing the parts used and then identified to know their scientific names.

### 2.2. Data Analysis



**Figure 1** Research site, the Kranggan Mas traditional market, Bekasi District, West Java Province, Indonesia

The data obtained in this study were analyzed qualitatively. Qualitative analysis includes grouping plants based on benefits, families, and parts used. To complete the secondary metabolite and plant bioactivity data, secondary data in the form of journals or the results of previous research related to alternative food types is carried out.

### 3. Results and discussion

#### 3.1. The Traders Characteristic

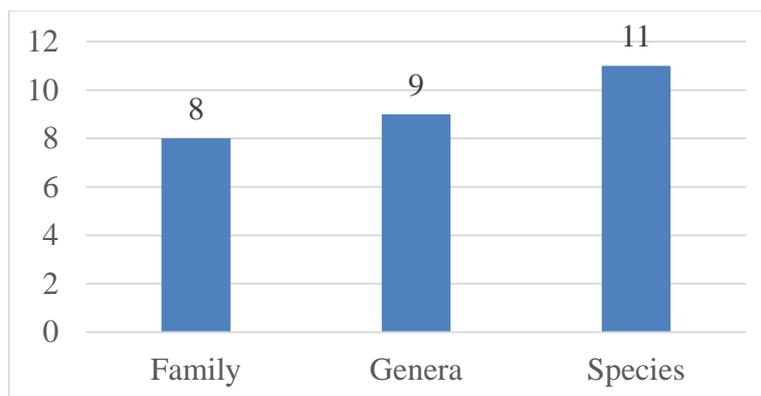
Traders of alternative food plants in the Kranggan Mas traditional market, based on the location of their trade, are divided into two, namely traders in open spaces and in kiosks. Traders in open spaces sell their wares starting at 03.00-07.00, while kiosk owners start opening their stalls around 05.30 to 17.00. In addition to selling alternative food ingredients, some traders trade other food ingredients such as spices and vegetables. The number of species traded by traders in open spaces is relatively less compared to traders who have kiosks. Most of the traders in the open space are male and sometimes assisted by family members (female).

#### 3.2. The Diversity of Food Alternative Plants

The alternative food plants are alternative carbohydrate sources that can be used by the community as a substitute for rice. In this study, alternative food ingredients are all plant species in fresh form (raw materials) which are traded as a source of carbohydrates other than rice or rice. A total of 11 species belonging 9 genera and 8 plant families as alternative food ingredients are traded in the Kranggan Mas traditional market (Figure 2 and Table 1). Based of the parts or organs that are used as much as 82% are tubers and the rest is fruit.

**Table 1** The alternative food plants traded at the Kranggan Mas traditional market, Bekasi District, West Java Province, Indonesia

Family	Scientific name	Local name	Part of uses	Price/kg (000 IDR)	Supply
Araceae	<i>Colocasia esculenta</i> (L.) Schott	<i>Talas Bogor</i>	Tuber	8-10	Few and seasonal
	<i>Xanthosoma sagittifolium</i> (L.) Schott	<i>Kimpul</i>	Tuber	10	Few and seasonal
Convolvulaceae	<i>Ipomoea batatas</i> (L.) Lam	<i>Ubi</i>	Tuber	7-10	Lot and every day
Cucurbitaceae	<i>Cucurbita moschata</i> Duchesne	<i>Labu kuning</i>	Fruits	8-24	Few and every day
Dioscoreaceae	<i>Dioscorea alata</i> L.	<i>Huwi</i>	Tuber	20	Few and seasonal
	<i>Dioscorea esculenta</i> (Lour.) Burkill	<i>Gembili</i>	Tuber	20	Few and seasonal
	<i>Dioscorea hispida</i> Dennst.	<i>Gadung</i>	Tuber	20	Few and seasonal
Euphorbiaceae	<i>Manihot esculenta</i> Cranz	<i>Singkong</i>	Tuber	4-5	Lot and every day
Lamiaceae	<i>Plectranthus rotundifolius</i> (Poir.) Spreng.	<i>Kentang hitam</i>	Tuber	15-20	Few and seasonal
Moraceae	<i>Artocarpus altilis</i> (Parkinson ex F.A.Zorn) Fosberg	<i>Sukun</i>	Fruits	10-15	Few and seasonal
Poaceae	<i>Zea mays</i> L.	<i>Jagung</i>	Seed	8-12	Lot and every day
Solanaceae	<i>Solanum tuberosum</i> L.	<i>Kentang</i>	Tuber	15-20	Lot and every day



**Figure 2** The diversity of plants as alternative food are traded in the Kranggan Mas traditional market, West Java Province, Indonesia

Each family has only 1 species except Dioscoreaceae and Araceae which have 3 and 2 species, respectively. Although Dioscoreaceae has more species, all of them are wild plants. Empirically, it can be seen that *D. alata* and *D. esculenta* are easy to find on vacant land or neglected land, such as the side of the road in the buffer zone of the Kranggan Mas traditional market. This plant is easily recognized by its climbing stature and heart-shaped leaves. Dioscoreaceae has been long used by humans as food, but these species have not been cultivated and are also less well known to the public. On the other hand, the price is relatively expensive compared to other carbohydrate sources, which makes consumers reluctant to buy and use it. Respondents stated that *Dioscorea* sp. consumers only belonged to certain groups such as elderly people.

Some of the alternative foods in table 1 are plants that are easily found in markets in various regions, such as corn (*Zea mays*), cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*) and potato (*Solanum tuberosum*). The availability of these foodstuffs is quite abundant and available at any time. Corn as an alternative food is sold in cobs or dried kernels.

Sweet potato as an alternative food has long been used by local Indonesian people. The sweet taste and relatively easy processing make sweet potatoes an alternative food favored by the community. This results in abundant supply in the market so that the selling price is relatively cheaper. *Ipomoea batatas* which is traded in the traditional market of Kranggan Mas varies which can be easily distinguished based on the color of the skin and the cross section of the tuber. The varieties of sweet potato that are traded include *ubi ungu*, *ubi cilembu*, *ubi putih*, *ubi orange* and *ubi merah* as well as *ubi jepang*. The color of the tuber skin varies from red, purple, cream, orange, and pink. Some sweet potatoes are sold in plastic packaging in 1 kg units. To improve air circulation in the packaging, the plastic is perforated. Each sweet potato character has a different taste (Figure 3)



**Figure 3** Variation of tuber colour of *Ipomoea batatas*. A. Morphology of tubers. B. Transverse incision of tubers

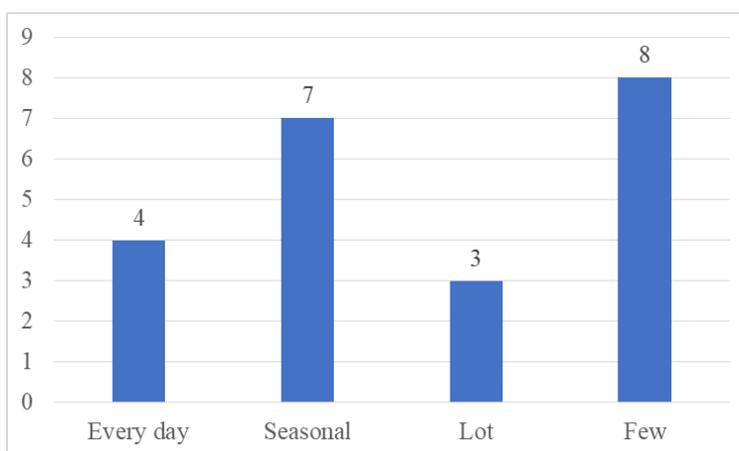
Cassava or *Manihot esculenta* is an alternative food with the most stock and the cheapest price compared to other alternative food ingredients. Cultivation that is relatively easy and resistant to drought has resulted in this plant being one of the reasons for people to cultivate it. On the other hand, cassava leaves are also often used as vegetables. Based on the characteristics of the skin color in cassava tubers are divided into two, namely tubers with red skin and white

skin. Red skin tubers when cooked have a softer texture so that the cooking process is faster than white skin, therefore the selling price is more expensive than white skin.

Dioscoreacea tubers have long been used by various ethnic groups in Indonesia as food. A total of 3 species from this family have been traded in the Kranggan Mas market, namely *D. alata*, *D. hispida* and *D. esculenta*. The three tubers of these species are easily distinguished from the size, skin texture and color of the tubers. The bulbs of *D. alata* are purple while *D. esculenta* is white. The outer skin texture of *D. hispida* is equipped with coarse fibers.

The *C. esculenta* (*talas Bogor*) and *X. sagittifolium* (*kimpul*) are belonging Araceae. The two types of species are easily distinguished from the tuber texture. The tubers of *C. esculenta* are round in shape and relatively large in size because they are part of a fleshy stem with short segments, while *kimpul* are smaller in size with an oval shape. When viewed from the supply, *kimpul* is easier to find than taro and the price is also cheaper. The tuber *kimpul* has scales and at the distal end there is a bud. The itching caused by the "sap" produced by taro tubers causes various people to be reluctant to use it.

Figure 4 shows the availability and supply of alternative food ingredients in the Kranggan Mas traditional market, namely 4 species available every day such as cassava (*Manihot utilissima*), sweet potato (*Ipomoea batatas*), potato (*Solanum tuberosum*), and pumpkin (*Cucurbita moschata*). Although *C. moschata* is available every day, the supply is very limited and is only sold by about 5-6 traders. The size of the pumpkin that is traded is 1.5-4 kg with a selling price of around 8,000-10,000 IDR per kilogram.



**Figure 4** The availability and supply of alternative food at the Kranggan Mas traditional market, West Java Province

As many as 7 species or more than 60% of the alternative food ingredients traded are available seasonally (supply only at certain times) such as breadfruit (*Artocarpus altilis*), *kentang pule*, taro, *kimpul* and *Dioscorea* spp. Factors affecting supply include: fruit is only produced at certain times (eg breadfruit), limited collectors (eg. *Dioscorea* spp. and taro), not yet cultivated (*Dioscorea* spp.). The *kentang pule* have a tuber structure that is almost like a potato. Traders classify the size of black potato tubers into 3, namely large (5-6 cm in diameter), medium (3-4 cm) and small (1-2 cm). The size of the potato tubers has implications for the selling price and the size is directly proportional to the selling price. Bulbs with large sizes are only found in certain months, especially May-July, which is related to the potato harvesting period in the buffer zone of the source of material in the Kranggan Mas traditional market such as the Jonggol area.

### 3.3. Alternative Food Plants Potential

Several alternative food plants found in the study will be discussed further, such as *D. alata* and *A. altilis* because the information is still limited.

#### 3.3.1. *Artocarpus altilis*

Breadfruit (*A. altilis*) is easy in the neighborhood around the Kranggan Mas traditional market. By local people, this plant is often used as a shade because it has a shady canopy and large leaves, so it can double as shade and food. The *A. altilis* fruit has the main content in the form of carbohydrates [10]. Liu et al. [11] stated that various cultivars of *A. altilis* contain total essential amino acids and protein, much higher than other food crops such as corn, wheat, rice, soybeans, potatoes, and peas. At the Kranggan Mas traditional market, *A. altilis* fruit has long been traded at a selling price of

10,000 –15,000 IDR per piece. Respondents stated that most consumers make breadfruit as a snack. Different things were reported by Roberts-Nkrumah and Legall [12] in Trinidad and Tobago that farmers that *A. altilis* had been consumed as food for households (90.1%), a source of income (67.9%), for shelter and traditional medicine (63.0%), and the demand tends to increase.

The *A. altilis* is a rich source of carbohydrates, minerals, vitamins [13] and protein [14,15]. Selection of foodstuffs based on the glycemic index is recommended in choosing food as a source of carbohydrates [16] because this information is considered to be helpful in health. The glycemic index of breadfruit is influenced by the processing process and it is reported that fried breadfruit, steamed breadfruit, boiled breadfruit, and breadfruit cookies are 82, 89, 85, and 80, respectively [16]. In addition to affecting the glycemic index, the processing process also affects the mineral content of *A. altilis* fruit [17]. The *A. altilis* fruit flour contains crude protein (4.31 - 4.85%), crude fiber (5.00 - 5.38%), starch (68.38 - 69.20%) and ash (2.56 - 2.90) [18]. The mineral content of *A. altilis* fruit such as potassium, calcium, phosphorus, magnesium, iron, sodium and manganese cooked by microwave heating is higher than that cooked by boiling. The average concentration of minerals (expressed as mg/100g of raw sample) was potassium (269.4), phosphorus (40.97), calcium (26.32) magnesium (24.35), sodium (1.41) iron (0.18910 and manganese (0.0381) [17].

The pulp of *A. altilis* fruit is rich in essential amino acids (49.59 g/100 g), predominantly lysine and leucine [15]. Amino acid, fatty acid, and carbohydrate content of *A. altilis* were 72.5%, 68.2%, and 81.4%, respectively, while the starch content was 15.52 g/ 100 g fresh weight [14]. The carbohydrate content of breadfruit is approximately 36% of the total carbohydrate, indicating that although the total carbohydrate content is high, most of it is high and is not easily digested and absorbed in the small intestine [19]. The protein content of various *A. altilis* cultivars had significant differences found in all varieties containing essential amino acids, especially phenylalanine, leucine, isoleucine, and valine [11].

### 3.3.2. *Dioscorea alata*

*Huwi* or *D. alata* is still found in the area around the Kranggan Mas traditional market, namely on vacant land and is easily recognizable from its stature in the form of a liana. To support its growth, this plant requires propagation and has many branches. When compared to other types of *Dioscorea*, *D. alata* tubers are tastier and easier to process with more attractive bulb colors. Day et al. [20] stated that *D. alata* tuber is a functional food with high nutritional value and therapeutic potential. Udensi et al. [21] stated that *D. alata* contains nutrients, namely the average crude protein (6.7%) and carbohydrate content (81.6-87.6%) are the main fractions of tuber dry matter. The mineral content of *D. alata* tubers per 100g was K (240-400 mg), Na (190-380 mg) P (180-340 mg), C (20.2-80.2 mg), Mg (24.3-97.2 mg) dry weight. The content of vitamin C in sweet potato tubers ranged from 16.7-28.4 mg/100g, fresh weight [21].

The nutritional value of *D. alata* varies depending on the cultivar and processing method. The proximate composition of yellow and purple *D. alata* ranged from crude fat (0.4-0.55%), crude protein (5-8%), fiber (16-26%) and starch (41-76%). Dioscorine and water-soluble polysaccharides are bioactive components of *Dioscorea* and the content of purple flour is greater than that of yellow flour [22]. Raw tubers of *D. alata* contained nutrients in the form of crude protein (10.27%), ash (2.93%) and fat (0.15%) a significant decrease in boiled tubers while carbohydrates (76.57%) significantly increased in boiled tubers [23]. The boiling is one way to remove anti-nutrients. Antinutrients in boiled tubers of *D. alata* were alkaloids (2.77%), saponins (2.71%), flavonoids (1.38%) and tannins (0.21%) significantly reduced in boiled tubers. Cooking times between 30 and 60 minutes at 100°C are recommended for *D. alata* [23].

Besides being rich in nutrients, *D. alata* tubers have anti-inflammatory properties. The *Dioscorea* spp. is a plant in the tropics that has been shown to increase sex hormones in postmenopausal women [24]. The *Dioscorea* ethyl acetate extract activates R and estrogen receptors. The *D. alata* extract containing hydro-Q9 chromene and -tocopherol-9, RRR-R-tocopherol, coenzyme Q, and 1-feruloylglycerol, identified and activated human ERR and [24]. Lin et al [25] reported that *D. alata* has tubers that store protein and have antihypertensive effects. Hypertensive rats fed protein from *D. alata* tubers were able to lower blood pressure comparable to captopril [25]. The hydromethanol extract of *D. alata* inhibited the expression of NO and TNF- $\alpha$  with IC50 values of  $134.51 \pm 6.75$  and  $113.30 \pm 7.44$  mg/mL, respectively. Its bioactivity as an antioxidant is thought to be related to its secondary metabolite content, namely hexadecenoic acid, methyl stearate, cinnamyl cinnamate, squalene bioactivity [20], phenolics and flavonoids [26]. The ethanolic extract of the bulbs showed strong DPPH radical scavenging activity [26].

## 4. Conclusion

A total of 12 species belonging to 10 genera and 8 families of alternative food plants are traded at the Kranggan Mas traditional market, Bekasi, West Java. The organs used as much as 82% are tubers and 18% come from fruit. *Dioscorea*

*alata* contains compounds containing dioscorin compounds which also function to reduce hypertension and are highly recommended for postmenopausal women.

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## Compliance with ethical standards

### Acknowledgments

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### Disclosure of conflict of interest

Marina Silalahi: participated in designing of the study, research, and manuscript preparation; Sunarto participated in designing of the study; Debora Pardosi and Teresa Riwana Marnala Munthe, participated in research; Riska Septia Wahyuningtyas participated in manuscript.

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