Starch Product of Wild Plants Species Jalawure (Tacca leontopetaloides L.) Kuntze as The Source of Food Security in The South Coastal West Java

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Abstract. Majority of people of South coast of West Java, from Sukabumi, Cianjur, Garut are fishermen. Natural conditions are very dry and the area of land for agriculture, particularly rice cultivation is minimal. So that the condition of the society is more directed to high enough levels of food insecurity. Because coastal areas tend to have a longer dry season from rainfall. Results of research conducted in the years 2013 - 2016 in the area of Pelabuhan Ratu, Cidaun (Cianjur), Coastal area of Jayanti, Ranca Buaya, Mekar Mukti, and along the coast until Pameungpeuk, Leuwung Sancang, is known that jalawure plant which grows wild at South-coast region of West Java is precisely the alternative solution to address food insecurity. The results of the starch flour is a source of carbohydrate that is high enough to be used as a substitute for rice and wheat. Another potential source of jalawure nutrition is also recommended for diabetics consumption.

1. Introduction
Indonesia as an agricultural country and maritime has a wealth of natural resources potential, it is natural to be able to meet food needs for the population, because food affects the community, the nation and the state, both in the economic, political, social, cultural and defense. Although the rice self-sufficiency had been achieved in 1984, but with the climate disruptions and change the orientation of economic development, so Indonesia again become a net rice importer. Associated with food needs in the broad sense, Indonesia also has not been able to achieve self-sufficiency, especially when associated with the fulfillment of carbohydrates, protein, fat, vitamins and minerals. The number of people are getting serious to press the availability of natural resources that can be used to provide food, which is already very limited. Indonesia is estimated to have population growth in 2035 will be double the current amount, to less than 400 million inhabitants. As a result, a period of 35 years Indonesia needs additional supply of food more than twice the current supply [1], so that efforts to achieve food security is a challenge that must be given priority to the welfare of the nation. National food production needs to be significantly improved so that domestic demand can be met, while food development in Indonesia still faces many problems. The problem is that food consumption of Indonesian is fixated on rice consumption, and government policies by freedom duties on rice imports in order to meet the availability of rice, but the implications for rice producers is deteriorated.
Though Indonesia has high biodiversity, the irony will be food shortages. Foodstuffs derived from tubers carbohydrates is still widely spread in all corners of Indonesia, which can be a source of carbohydrates as food alternative. In this case the Research Center for Biology LIPI as the agency in charge of increasing the basic knowledge of science, its role in enhancing the country's food security is expected. One of the activities conducted is looking for wild plants as an alternative source of food. Data and information obtained from this study are expected to be the foundation in the development of the use of plants by other competent agencies in the field. In this case the research is directed at the species of minor tubers relatively unnoticed by the other institutions to be developed. Therefore *Tacca leontopetaloides* is one kind of tubers that became the main target of the study.

*Tacca leontopetaloides* plant is known locally different in each region, kecondang, condang (Java), labin (Madura), kecondang (Seribu Islands). Also in Tahiti is known as arrowroot or Polynesian arrowroot [2-3]. Jalawure (*Tacca leontopetaloides*) is known by the coastal communities in Sukabumi, South Cianjur and South Garut as a plant that has been used by local communities since their ancestors is hereditary in overcoming conditions of famine and food shortages that often occur in their area. This is due to the westerly winds that blow away the heat, which causes the fishermen not to fish and harvest failures. Various studies on this species have been done such as on physiological aspect [4] and ethnobotanical aspect [5].

Tubers of jalawure (*Tacca leontopetaloides*) is processed by the local community in the research sites to serve as a substitute for rice starch or flour to overcome food shortages and famine [6]. The results of the analysis carried out in the Department of Health and Nutrition Research Center on Post Harvest Lab Department of Agriculture on Tacca tuber starch turns that carbohydrate content of the starch flour is quite high i.e., 83.07% -89.4% and storability of flour could reach 1 to 1,5 years [7]. This species is found growing wild in the coastal areas of West Java. Regarding this species in Indonesia is still rarely carried out, both from the aspect of ethnobotany, cultivation and other aspects, including the excavation efforts in exploiting their local wisdom. The existence of this plant begins rarely found in nature, this is due to iron sand mining and shrimp ponds in coastal areas of research location. Therefore, this study aimed to determine the indigenous knowledge of local communities, the importance of this plant as a food source of carbohydrates that can be used as an alternative solution in facing famine and food insecurity in order to feed themselves for food self-sufficiency.

2. Materials and Methods

2.1. Time and Research Location

The study had been conducted in 2011 to 2015 in the coastal areas of South West Java. The research locations were in Kertajaya village, Simpenan sub-district, Sukabumi regency; Cidamar village (Jayanti beach), Cidaun sub-district, Cianjur regency and to the regency of Garut (Rancabuaya, Cicalobak; Cigadog, Cikelet, Santolo beach, and Sayangheulang). Climatic conditions at the study sites according to the classification of Schmidt and Ferguson, including climate type B, i.e. the wet type with value $Q$ (Quotient) amounted to 24.19% where $Q$ is the percentage ratio between the average number of dry months with the average number of wet months. Duration needed to get to the location of the study in normal conditions is about 12 hours, but when the bad weather, the rain and fog, can reach 15 hours.

2.2. Working Procedures

Data was collected through interviews with members of the local community, village head, village chief, sub-district, Gapoktan, KWT, and the people who use the plants, especially on jalawure (*Tacca leontopetaloides*). Interviews were conducted openly and freely. Direct field observations in a way to traverse along the coast based on information from the local community. Starting from the coast of South Cianjur to the coast in South Garut in West Java by purposive sampling (where plants were available). Besides interviews there were also collecting plant samples for specimen sample (voucher), and plant parts such as tubers and flour used for proximate analysis and mineral.
3. Results and Discussion

3.1. Results

3.1.1. General Situation of Research Sites

Pamipiran, Sangrawayan, and Citamiang sub-villages are administratively included in Kertajaya village, Simpenan sub-district, Sukabumi regency and located between 7° 04'50.8" S, 106° 32'46.5" E, research is located in the coastal hamlet, a population of approximately 175 people consisting of 56 families. Conditions of hamlet is directly facing the Indonesia Ocean with a height of 20 m-50 m above sea level. The research location is hilly topography and steep cliffs up ramps. Population is Sundanese, majority of Islam religion, and the main livelihood of the fishermen is catching fish in the sea. They do rice paddy farmland on low sloping section, and the results are not enough to feed them one month. Because the land with an area slightly too infertile, they are planting other tubers but oftenly consumed by wild boar. Therefore, people who live in this area often had a bad season and food insecurity.

Cidamar Village, Cidaun sub-district, South Cianjur, Cianjur regency is located between coordinates 7° 29'13.1" S 107° 21'18.4" E. The total area of about 1.89 million ha is located on the south coast ± 10 meters above sea level. With rainfall ± 2000 mm/year and a rainy months for 6 months, Cidamar village has a daily average temperature ranges between 29°C - 32°C. Main livelihoods are fishing and farming.

Rancabuaya beach is located in the Purbayani village, Caringin sub-district, Garut regency, West Java. North side of this site is adjacent to the Caringin village, south adjacent to the Indralayang village, the east by the Sinarjaya village, and west by the Indonesian Ocean at coordinates 7° 31'42" S, 107° 28'46" E. Other sites are Cicalobak beach of Mekarmukti sub-district; Village of Cigadog, Santolo beach, sub-district of Cikelet is located at 7° 39'40" S and 107° 41' 11" E; and Sayangheulang beach, Village of Mancagahar, Pameungpeuk sub-district is at 7° 40'6" S, 107° 52'18" E, and Nature Reserves of Leuweung Sancang 7° 41'48" S, 107° 52'18" E are all in Garut regency. The total area of 2248.83 km², or approximately 73.37% of the current Garut regency with a population density of 1,171,846 inhabitants (census of 2010), or about 43% of the total population of the Garut regency today. The main livelihoods are farming and fishing communities to catch fish in the sea.
3.1.2. Botany Information

According to [8], the genera *Tacca* consists of 8 species including *Tacca leontopetaloides* (L.) O. K., synonym of *Tacca pinnatifolia* Gaertn. This plant is herb, growing wild, up to 2 meters. Tuber rounded, flattened or elliptic, thin-skinned brown when young and dark brown when a bit old, inside the tuber white milk, grows under the ground to a depth of about 50 cm. Midrib rounded leaves and stems widen the breech eggs grooved and dark green fruit which generally consists of 20-40 fruits (see figure 2).

![Figure 2. Plants and development of *Tacca leontopetaloides*](image)

Inflorescence has flowers 1:25; 20-40, the flowers are protected by the green outer involucrum sometimes edged violet, or yellow, grow upright, can reach 40 cm long. Fruit dark green, green, rounded, rounded eggs or elliptic. Seeds many, varied forms of its size.

*Tacca leontopetaloides* on the coast of West Java, is known by the local name "jalawure" (South Cianjur and South Garut), in Sukabumi the name is "jalamure". In Central Java, on the island of Karimun Jawa is known by the name "kecondang", on the island of Madura is known as the "lorkong". In Central Java and Madura this plant is used as food only at certain times only. In Indonesia, it is found in such as the island of Madura, Krakatau, Karimunjawa islands and several other islands. In Garut, jalawure is found on the beach in the coastal of Cikelet sub-district. Jalawure grows at the seaside on a sandy soil under the shelter of a number of plant species such as pandanus, thistle and daffodil. [9] and [10], state that jalawure is a tropical savanna plant that can live in the dry season because it has a tuber that can store water.

3.2. Discussion

So far we only know rice as a staple food source of carbohydrates for satisfy nutrition for the community. But the price of rice is now perceived to be quite high for the people who live in rural areas, particularly those living on the seashore of the least fertile land and rainfed. Therefore, since 1962 jalawure has been used by people who live in the sub-village Cicadas of Cigadog village, South Garut as food alternatives to cope with the famine and food shortages that hit the village. Jalawure (*Tacca leontopetaloides*) is processed to be used as food ingredients with variations depending on the capabilities of each member of the family. The role of jalawure for people on the south coast of West
Java greatly assists government programs in terms of food self-sufficiency. This is apparent in difficult conditions, the people in this region can overcome its own problems by making jalawure as being substitutes of rice [7]. At first, Cigadog village has a population of poor and food-insecure around 60%, through the guidance and direction, the village eventually could reduce the population living in poverty to 20% (data of Cigadog village office 2014). This is because people try to cope with the crisis-prone fed and how to process local food sources that exist around them into local food instead of rice. Jalawure as one species of local minor tubers grow wild in the coastal is processed into foodstuffs. The work done by the village of Cigadog is awarded with Adhikarya Food Nusantara in 2011 from the government. Because of Cigadog villagers creativeness to process a variety of local food into food of carbohydrates substitute.

Results of research conducted in communities from South Cianjur area to Pameungpeuk of Garut regency show that the community in this area has been utilizing Tacca since their ancestors as a food substitute in famine conditions. However, as the transportation is smooth to the southern coastal areas, local wisdom in utilizing existing vegetation around them began to erode with the inclusion of a variety of food from outside the area which instantly can be eaten. Besides a disturbance at the plant habitats with the exploitation of iron sand mining and aquaculture ponds in coastal is already started to spread along south coast of Garut make communities that had been easy to get this plant is now getting hard to find it. This research is done in order to encourage the community to preserve the resources of Jalawure to remain a source of local food by the way it is grown, without depleting the habitat.

3.2.1. Potential tuber starch of Jalawure (Tacca leontopetaloides)

Results of research conducted in the Caringin, sub-district of Cidaun, South Cianjur, in the coastal communities Tacca tuber is used in a simple way, processed as starch flour for daily meal together with burned small fish. This shows the poor life condition of fishermen in this region. This is due to the people in this area who depend on the goodness of nature for fishing. Starch of Tacca tubers has a very important role in the lives of people in this area as a food ingredient to overcome food shortages. Communities in South Garut from Purbayani village, coastal of Rancabuaya, Cikelet village, the village of Cigadog and until Pameungpeuk utilize starch from tubers of jalawure is more advanced than the people in South Cianjur. In addition to consume as a food substitute for rice and wheat flour, they process them into various foods for the big days such as the Feast and at weddings. The role of this plant in the community is very large, but the process of making flour starch is still indispensable hygiene processing technology and quality. Because of the way of processing technology that can improve the quality of the flour is also the quality of food products produced.

Research conducted by LIPI in South Garut from 2011 to 2016 has made a considerable improvements to the coastal communities of this area. Tacca leontopetaloides plants that had only been utilized by the communities living on the seashore, now almost all the people in the study site knowing this plant without worrying in to use them as food. Tacca leontopetaloides is a plant that is still wild scattered along the south coast of West Java, and is starting to do its development. Making a pilot demonstration plot has been done so that local communities can cultivate without having to take the wild continuously. The development of this species is done in cooperation with the local government area of the Garut regency to see the potential in the future to replace the consumption of wheat flour into Tacca leontopetaloides flour. Propagation is done by intercropping with maize, peanut or also with green beans, for around 8-9 months of age Tacca to be harvested. So tuber harvesting is done after 3 times harvesting of corn. Because the harvesting season of the tubers falls during the dry season and other crops can not be harvested except Tacca tubers. At that time the tubers are old and starches is produced quite a lot [6].

3.2.2. The nutritional value of tuber starch flour of Tacca leontopetaloides
Result analysis of the nutrient content of tuber starch flour of jalawure \((Tacca\ leontopetaloides)\) per 100 gram portion which can be consumed, it contains the potential to be developed as an alternative food ingredient see table 1. Apparently the results of the analysis shows that starch flour has the potential to develop into an alternative foodstuffs and to make starch from wild tubers Tacca is similar with the flour-starch from other minor tubers that have been cultivated and developed. The chemical composition of starch tubers of wild Tacca for the content of protein, fat, carbohydrates, can compare the nutrient content for the types of tubers such as tapioca starch, white sago flour, tubers of \(Dioscorea\ esculenta\), black potato tubers, canna tubers etc. (Table 2).

Table 1. Nutrient content of \(Tacca\ leontopetaloides\) starch per 100g

| Analysis                | Nutrient content /100g |
|-------------------------|------------------------|
| Protein                 | 5.23                   |
| Fat                     | 0.785                  |
| crude fiber             | 1.85 %                 |
| Carbohydrate            | 80.11 – 88.07 %        |
| Energy                  | 334-369.165kcal/100g   |
| Mg                      | 221mg/100g             |
| Fe                      | 6.185mg/100g           |
| Ca                      | 283.2mg/100g           |
| K                       | 616.635mg/100g         |
| P                       | 233.105mg/100g         |
| Water content           | 15.65g/100g            |
| ash content             | 1.3g/100g              |
| amyllopectin            | 53.28 %                |
| amylase                 | 23%                    |

Source: [7, 11]

The value of protein and fat of Tacca flour is lower when compared to rice, but with the addition and processing can improve the nutritional value of Tacca and this can be proven that over the years the people in the South shores of Garut can survive in conditions of famine and food insecurity. Table 1 shows that the Tacca flour content of carbohydrates is high compared with other tubers (table 1 and 2) and also contains vitamin C, fat and protein (table 1.). Content of this flour included in classification of Low Glycemix Index, this product is suitable for development as the possibility of consumption for diabetics. Unlike the case with natural Glycemix carbohydrates with high indexes, such as rice and corn [12]. Another advantage of the wild tuber starch flour of Tacca is based on research results is the amylose content of the starch is high (31.08%) and amylose content in a starch said to be high if it is> 25%. Amylose content of the Tacca starch is high to cause swelling of the starch granules and starch limited solubility. So it is suitable for food processing of some kind of noodles, because it will produce a strong high breakage noodle while still raw, cooking loss of solids due to the low, low adhesiveness and high tensile strength. High amylose content in Tacca starch, also demonstrated the potential Tacca starch as resistant starch. Starch with high amylose content, crystalline structure will tend to be more difficult to
digest. Besides acute toxicity tests have been conducted on the Tacca flour that shows practically non-toxic [13].

Table 2. Content of nutrients from minor tubers per 100g

| Types of Samples     | Fat (g) | Protein (g) | Carbohydrate (g) | Ca Mg/100g | P Mg/100g | Fe Mg/100g | Vit.C mg/100g | Ash content (g) | Water content (g) | Energy (Kkal) |
|----------------------|---------|-------------|------------------|------------|-----------|------------|--------------|-----------------|------------------|---------------|
| Wheat flour          | 1.3     | 8.9         | 77.3             | 16         | 160       | 1          | 1            |                 |                  | 365           |
| White sago (Maranta arundinacea) | 0.2     | 0.7         | 85.4             | 8.3        | 23        | 1.45       | -            | -               |                  | 346.2         |
| Cilawu tuber         | 0.7     | 1.8         | 27.9             | 30         | 49        | 0.7        | -            | -               |                  | 125.1         |
| Manggu cassava       | 0.6     | 2.8         | 78.5             | 33         | 56        | 0.55       | -            | -               |                  | 330.6         |
| Legi tuber           | 0.1     | 1.1         | 2.1              | -          | 40        | 0.2        | -            | -               |                  | 89            |
| Gadung               | 20      | 0.2         | 23.1             | 79         | 0.6       | 9.1        | 0.1          | 0.9             |                  | 73.5          |
| Kimpul               | 26      | 0.4         | 34.2             | 54         | 1.4       | -          | -            |                 |                  | 63.1          |
| Dioscorea esculenta  | 14      | 0.1         | 20.4             | 49         | 0.8       | 4          | 0.5          |                 |                  | 75            |
| Canna                | 21      | 0.11        | 22.6             | 70         | 1.9       | 10         | 0.1          |                 |                  | 76            |
| Black potato         | 34      | 0.4         | 33.7             | 75         | 0.2       | 38         | 0.02         |                 |                  | 64            |
| Taro                 | 61      | 28          | 1.9              | 61         | 1         | 17         | 0.13         |                 |                  | 73            |

Source: [14]

Selection of the types of food and consumption patterns that are less appropriate can cause various diseases, including diabetes mellitus, hypertension, heart disease, and cancer. Carbohydrates consumed from a food will be digested and absorbed by the body. The higher the faster or a starch digestibility, the more glucose is generated to cause an increase in blood glucose levels. Carbohydrates are slow digesting power to be consumed by diabetics because of the increase in blood glucose becomes slow. The starch digestibility of each food is different, and can be detected through approach of glycemic index (GI) value. GI value of a food is influenced by many factors. One of the main factors that affect the value of GI is the absorption rate of carbohydrates by the body of a food [15].

3.2.3. The process of making flour tuber starch of Tacca

Processing technology of starch from tubers of Tacca wild plants which still done by the people is very simple, but to get a quality starch people need guidance. Guidance and awareness has been done to farmers Gapoktan, KWT, the PKK and the surrounding coastal communities to cultivate the fresh Tacca tuber hygiene and quality. The current result of Tacca starch quality when compared to starch that has been set by SII (Standard Industrial Indonesia) indicate that Tacca starch can achieve these standards. Judging the results of the starch flour which has almost the same level of whiteness with tapioca flour.

The processing of tubers into flour starch is done by a simple technology. To get a good quality flour is firstly in terms of raw materials (the tubers). Tubers are taken on the right harvest time which is during dry season, brown tuber skin without injuring oldness and harvesting the tubers. Because the Tacca tubers are very easily injured if exposed to scratches, streaks will cause brown color and that part will be rotten, so the flour quality is not good [6-7]. After the tubers are harvested then: a) soaking the tubers while cleaning the dirt from sticking; b) followed by removing the outer skin layer tuber with a
brush or knife by means of scraping, the outer skin is easy to clean because it is soft after soaking; c) tubers already scraped then soaked with clean water; d) scarring the tubers; e) then filtered to obtain a starch; f) starches that have been obtained then re-soaking up water from starch flour, shall be considered the work is completed; g) then the starch is to dry (figure 3).

![Soaking Tubers](image1)
![Cleaning](image2)
![Scarring](image3)

**Figure 3.** The processing of starch Tacca

![Squeezing](image4)
![Filtering](image5)

![Scarring](image6)
![Squeezing](image7)
![Filtering](image8)
![Precipitation](image9)

**Figure 4.** The process of manufacture of starch with mechanical technology

Processing to produce starch either traditional or managed using the same means of mechanical technology - can produce the same quality of starch. The difference is if the management of starch in the scale of home industry can be done in a simple, but if in a large scale rather difficult to do because it uses energy scarring. The resulting starch yield levels did not differ with producing tapioca starch. The yield of tuber starch flour of Tacca is quite high if the raw materials in a timely harvest is about (30% -35%) [16] and tapioca flour around (25%) [17].

### 3.2.4. Prospects of tuber starch of Tacca

Tacca tuber starch is proved to have good prospects, and could be a wise choice to meet the needs of local food-based raw materials with consideration of its main raw material of jalawure (*Tacca leontopetaloides*). Because the development on the local habitat, with most of the agro-climatic coastal land stretching, the low cultivation cost, productivity is high, produce large enough tubers. The execution management is easy enough that a housewife could manage their own needs, do not require a mechanical technology that will spend money on the process. Cassava growers are also planting in this area, the constraints is on the time of harvesting, cassava prices is low due to unstable price fluctuations, thus allowing it to be pursued. Finally, the low sale price of cassava, cassava farmers are forced to sell at low prices. To be processed into flour can not be done in the home industry, as cassava is difficult to do scarring.
Development of the current Tacca starch can improve the lives of farmers, because of Tacca starch can be used as raw material to be processed into various food products, see figure 5. One of the advantages of the Tacca tuber starch flour can survive long enough around 1.5 years [16]. Therefore, the flour has a fairly large prospects as food raw materials to tackling food shortages and famine.

![Figure 5](image)

**Figure 5.** A wide variety of products that can be produced from starch tubers of Jalawure. Description: 1. A noodle product produced from starch of jalawure; 2. Jalawure syringe Cake; 3. Jalawure cork cake; 4. Cheestick of jalawure; 5. Jalawure semprong cake; 6. Jalawure rose cake; 7) Snow princess cake of jalawure.

In the industrial manufacture of noodles, biscuit or flour-based bakery, materials and equipment required is relatively simple. If during the many small industries that can operate with flour raw material, why we do not try to replace it with tuber starch flour of Tacca. This would mean at the present time, especially since it would reduce imports of wheat flour as a raw material. In addition to the number of companies that lay off employees right now, people will have difficulty finding job. With the industrial manufacture of jalawure tuber flour and dairy products will absorb a certain amount of labor. This will at least help a little on economic difficulties that so far have not passed in our country. Moreover, because the price of raw materials is cheaper, the price of flour produced from jalawure tubers will also be cheaper. The benefits arising from the utilization of sweet potato flour efforts is the emergence of the processing industry allows absorption of surplus labor generally found in rural areas, the processed food industry to reduce the cost of production and its dependence on wheat, the country could save foreign exchange through a reduction in imports of wheat. It is expected that Tacca tuber flour and dairy products can be accepted by consumers to further the success of diversification as one of the government programs. The success of this food diversification efforts will increase the economic value. Besides efforts to disseminate the use of jalawure tuber flour and processed results is also expected to achieve food security in Indonesia. Currently the manufacture of noodle products from raw materials of Tacca starch tubers are in the process which is more geared to functional food.

4. Conclusion
*Tacca leontopetaloides* is one kind of minor tubers that are wild and not yet widely cultivated. Apparently the result of research conducted in the coastal areas of West Java, namely in the village of Kertajaya, sub-district of Simpenan; Cidamar village of Cidaun sub-district; areas along from
Rancabuaya to Pameungpeuk sub-district, tubers of *Tacca leontopetaloides* have been used since time immemorial for generations by the community to replace rice as the main source of food. Starch flour is used as a substitute for rice or starch flour to overcome the famine and food shortages that often occur. Knowledge of Taccia plant can lift local communities to improve their living standards by creating a wide variety of food products to their market. Its starch flour is also recommended for functional food ingredients.

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