Morphological characterization and development potential of beneng variety \((Xanthosoma undipes \text{ K. Koch})\) Pandeglang - Banten

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Abstract. Beneng is a local giant taro that is easily found around the Gunung Karang areas, Pandeglang District, Indonesia. Beneng has the potential to be developed as a commercial crop due to high demand of its product (tuber and leaves). Therefore, the study aimed to characterize the morphology of Beneng, and to analyze its potential development. The research was conducted in Juhut Village, Pandeglang District, Banten Province from 2017 to 2020. Morphological characterization was observed following the guidelines on the descriptor for taro. A series of data were collected from Beneng farmers and the Beneng Association. Beneng is a unique crop with a big yellow tuber. Besides, all parts of the crop are useful and economically valuable. Beneng can grow well under, and well adapted to, low light intensity. Therefore, this crop is suitable as a secondary crop in plantation areas or intercropped with other tall crops. Additionally, Beneng is a food crop with a high carbohydrate content (78%) which is suitable as a fresh product or processed products (flour and chips). Beneng dried leave is also valuable as herbal teas and tobacco. High demand of Beneng product showed that Beneng has a comparative and competitive advantage as compared to other types of taro. Currently, Beneng is marketable for export to other countries. The demand for fresh tuber, flour, and dried leaves reached 60-80, 200, and 300 ton per month, respectively. Our study showed that Beneng plants can produce 10-15 kg fresh tuber or around 100-150 ton per ha, and can be as much as 2 kg per plant dried leaves or around 20 ton per ha, with the total plant growth duration of 8 to 12 month. In order to fill the gap between demand and supply of Beneng products, an expansion of Beneng cultivation is needed through optimizing the arable land around Gunung Karang and surrounding areas.

Key words: taro, export, superior, large tubers, dry leaves

1. Introduction

One of the food plants that has a fairly high diversity is taro. In general, Indonesia has 4 types of taro, namely \(Colocasia\), \(Xanthosoma\), \(Alocasia\) and \(Cyrtosperm\). The type of taro that is best known to the public is the \(Colocasia\) type such as Bogor taro. Taro can be used as a staple food because it is a potential source of carbohydrates (about 90%), also contains minerals that are important for health such as calcium, magnesium, iron, zinc and other minerals and has a higher protein content (20 g / kg) compared to other tubers such as sweet potato and cassava which is only half. According to [1] 98.8% taro tubers can be digested because they have starch which contains a lot of amyloses (20-25%), which can be broken by human saliva. This type of carbohydrate is very good for people who have digestive problem, therefore wheat flour is suitable for consumption by babies [2]. Besides, taro tubers are a good source
of dietary fiber, vitamin B6, and Mn. Some taro tubers contain 7 g protein / 100 g tubers and taro Belitung contains lots of vitamin C [3].

Banten Province has a large type of taro (Xanthosoma undipes K. Koch), which the local community calls taro Beneng. The name taro Beneng was started in 2008, at that time, this type of taro began to be used by the people of Juhut, Karang Tanjung sub-district, Pandeglang Regency as a source of carbohydrates and other traditional processed products. The term Beneng originates from the morphology of taro which has large and yellow tubers (beuneur and koneng in Sundanese). The rapid use of talent, followed by an increase in the planted area of this crop, implies the need to provide large quantities of seedlings. Provision of seeds in large quantities must refer to the principles of seed/seed production so that the purity, quality and superiority of the variety can be maintained. In connection with this in 2016 the UPT for Supervision and Certification of Food Crops, Horticulture and Plantation Seeds (PSBTPHP) of Banten Province, the Office of Agriculture and Plantation of Pandeglang Regency, and the Banten Agricultural Technology Research Center (BPTP) conducted observation tests, characterization and evaluation of the Beneng Taro plant. which is in Pandeglang Regency. The results of characterization were followed up by registering taro Beneng to the Center for Plant variety Protection and Agricultural Licensing in 2017 with registration number 256 / PVL / 2017. Followed by the release of Beneng varieties with Decree Kepmentan no.981 / HK.540 / C / 10/2020 stipulated since October 13, 2020, which stipulates that Beneng has become a national superior variety. This gives the Regional Government as the owner of the area the mandate to have to develop and allocate land for the production of Beneng seeds [4, 5, 6, 8, 9, 10, 11].

The prospect of developing Beneng is currently not only broadcast in the country but has reached overseas. The uniqueness of the tubers and their superior quality is one of the attractions in the commercialization of Beneng. One of the unique characters that characterize it is the large, light yellow tubers that are characteristic. Besides, the commercial appeal, especially in its development, is the leaves which have advantages over other types because the leaves are said to be the raw material for export. Due to the high demand for leaves in forms such as tobacco / chopped. The research objective was to characterize the morphology of the Beneng and study its development potential.

2. Material and Methods

2.1. Time and place

The time of observation and observation was carried out in 2017-2020. Observations were made in three locations, namely a) Locations in Cinyurup Village, Juhut Village, Karang Tanjung District, Pandeglang Regency (as the origin), b) Mandalawangi District, and c) Cisata District. The data collected were qualitative and quantitative data on the morphological performance and production of taro Beneng collected during 2 growing seasons in three locations (Juhut, Mandalawangi and Cisata). Plant morphological observations were carried out during the vegetative and generative phases, while to measure the level of productivity and yield potential was carried out during the harvest phase (age 8-12 months). The number of plants observed was 50 plants from 10 observation blocks. Plant blocks were used as a replication, and for each replication 5 observation samples were taken. Morphological characters and production performance were observed based on the Guidelines for Characterization and Evaluation of Taro Germplasm [7].

2.2. Morphological Character

Morphological characters in the vegetative phase that were observed included plant height, number of leaf midribs, color midrib, leaf edge shape, leaf bone pattern, shoot color, plant crown shape, branching patterns, stem cross-section shape, bark texture, bark color, shape leaf size, leaf surface color, underside color, leaf direction, leaf cleavage, leaf midrib length, and young leaf cycle. While the morphological characters in the generative phase observed included tuber shape, tuber length, the color of tuber flesh, level of tuber fibers, the thickness of tuber skin, tuber diameter, color of young crowns, number of flowers in bunches, flower shape, the color of stamens, and place of growth flower.

Observation of tuber yield characters was calculated based on the average tuber weight value obtained from 50 tuber samples from 10 observation blocks. From each observation block, tubers with
different ages of harvest, ranging from 8 - 12 months, and from different seed sources were taken, seedlings from tuber shoots (the rest of the previous cropping) and seedlings from buds. A total of 2 samples of tubers aged 12 months were taken from each block to calculate the potential yield. The sample for calculating the yield potential is tubers whose plants come from tuber shoots. Morphological characters in the vegetative phase that were observed included plant height, number of leaf midribs, color midrib, leaf edge shape, leaf bone pattern, shoot color, plant crown shape, branching patterns, stem cross-section shape, bark texture, bark color, shape leaf size, leaf surface color, underside color, leaf direction, leaf cleavage, leaf midrib length, and young leaf cycle.

While the morphological characters in the generative phase observed included tuber shape, tuber length, color of tuber flesh, level of tuber fibers, the thickness of tuber skin, tuber diameter, color of the young crown, number of flowers in bunches, flower shape, color of stamens, and place of growth. The data collected in the form of morphological and agronomic data were analyzed using the coefficient of diversity, to determine the level of diversity of the Beneng Beneng population in the population of the origin and development areas. Production data per tree taken for the last 3 years.

2.3. Potential Development
Beneng taro can grow well at an altitude of 200 - 1000 m above sea level on sandy lat texture soil, Beneng taro seeds from tillers can be used after the age of 2 (two) months or can be used seeds from the base of the stem after harvesting, farmers use a lot of the base of the stem for planting come back because it's growing faster. Beneng taro production potential varies between farmers, depending on environmental factors and cultivation methods. Environmental factors that influence are the level of land fertility and water availability. Meanwhile, plant cultivation includes fertilization application, spacing, seedling origin, and plant maintenance. Spacing greatly affects productivity, in general, spacing is related to cropping patterns. The intercropping pattern is more common in which taro Beneng is planted in mixed gardens or under stands so that the spacing varies according to the existing planting population. Meanwhile, the monoculture cropping pattern is generally arranged in gardens specifically for Beneng taro with a typical spacing of 1 x 1 m. The population of intercropping plants is lower than in monocultures with the number of plants planted in 10,000 m2 less than 1000-4000 plants/ha. Meanwhile, with a monoculture system, the plant population per 10,000 m2 ranges from 8000-10000 plants/ha. The origin of the seeds also has an effect on production, the seeds from the weevil leftover from the harvest will generally grow faster and have tubers than those from tillers. At the age of 8-12 months of harvest, boggo seedlings will be able to produce between 2-3 kg / plant, while those from tillers only range from 0.7-1 kg/plant.

3. Results and Discussion
3.1. Beneng Characterization
Characterization was carried out in three sub-districts, namely Juhut, Mandalawangi and Cisata, regarding the morphological characters in the vegetative and generative phases of the Beneng plant. The characterization results are shown in Table 1.

| Beneng Characteristic | Juhut       | Cisata      | Mandalawangi |
|-----------------------|-------------|-------------|--------------|
| Plant height          | 225.7±12.5  | 162±62.5    | 152.3±8.4    |
| Petiole height        | 182.3±15.7  | 126.3±14.7  | 134±13.5     |
| Leaves number         | 5±0.1       | 5.3±0.6     | 5±0.3        |
| Leaves height         | 108.7±12.4  | 70±10.6     | 88.7±3.8     |
| Leaves width          | 64±2.6      | 43.3±5.5    | 55.3±2.3     |
| Tuber height          | 64.7±15     | 65.7±15.2   | 57±11.1      |
| Tuber weight          | 9126.7±2610.2 | 9948.3±3047.1 | 8992±934.4  |
Beneng taro can grow well at an altitude of 200 - 1000 m above sea level on sandy loam soils. Beneng seeds from tillers can be used after 2 (two) months or can be used seeds from the base of the stem after harvesting. Farmers mostly use the base of the stem for planting, because it grows faster. Beneng taro production potential varies between farmers, depending on environmental factors and cultivation methods. Environmental factors that influence are the fertility of soil and water availability. Meanwhile, plant cultivation includes fertilization, spacing, seedling, and plant maintenance.

### Table 2. The geographical distribution of taro Beneng in 2015-2019

| No. | District | 2015 | 2016 | 2017 | 2018 | 2019 |
|-----|----------|------|------|------|------|------|
| 1.  | Jiput    | 0    | 0    | 2    | 3    | 3    |
| 2.  | Menes    | 0    | 0    | 2    | 3    | 3    |
| 3.  | Pulosari | 0    | 0    | 2    | 2    | 2    |
| 4.  | Carita   | 0    | 3    | 3    | 4    | 4    |
| 5.  | Cadasari | 2    | 2    | 4    | 4    | 6    |
| 6.  | Pandeglang | 2   | 4    | 4    | 4    | 5    |
| 7.  | Mekar Jaya | 0  | 0    | 3    | 3    | 3    |
| 8.  | Mandalawangi | 3  | 5    | 5    | 5    | 7    |
| 9.  | Cisata   | 5    | 5    | 5    | 5    | 5    |
| 10. | Karang Tanjung | 30 | 40   | 40   | 50   | 50   |
|     | Total    | 42   | 59   | 80   | 83   | 88   |

Sources: Agriculture Agency of Pandeglang District [15]

Pandeglang Regency (10 districts) and Serang Regency (2 Districts) [15]. Currently, the demand for tubers and leaves is quite high both domestically, especially in Central Java, East Java and Sumatra. In addition, demand from abroad has also made Beneng a target for commodity exports through three-time export movements (gratieks) to several countries such as Australia, New Zealand, Turkey, Malaysia and the Netherlands. Besides that, processed taro seeds have also increased. Developed outside the Banten region, including Bogor, Depok, Cianjur, Jakarta, Bekasi, Tangerang, Palembang, Lampung, Pekanbaru, Sukoharjo and Banjarmasin [16]. The need for processed products in the form of flour can reach 30-50 tons/month. After Beneng was designated as the national superior local variety by the Minister of Agriculture as of October 13, 2020, the production of source seeds became the next target for development.

### 3.2. Beneng Development Prospects

Beneng taro produces various types of marketable products. Marketing of taro Beneng is not only the result of fresh taro but also can be processed in the form of flour, taro chips, cakes and others [2]. Beneng taro flour can be used as processed Beneng taro noodles, Beneng taro cake, ice cream and various other cakes. Beneng taro can also be used as other processed foods, including cystic and chips. Amylose and amylopectin content of talas Beneng starch are 28.91% and 53.41%, so that this starch is suitable for application in food products that require compact gel strength such as vermicelli, cup noodles, or noodles [14]. Beneng taro production, apart from developing and utilizing its processing in Pandeglang Regency, is also outside Pandeglang Regency, including Tangerang City (Beneng taro sponge outlet), Serang Regency and even outside the Province, namely Bogor, Depok, Jakarta, Cianjur, West Java the bakery uses Beneng taro flour. In addition, other products found are nata de taro [13]. So that the derivative product of Beneng becomes more varied.

### Table 3. Components Wet leaves Dry leaves Wet tubers Dry tubers of Beneng

| Components     | Wet Leaves | Dry Leaves | Wet tuber | Dry tuber |
|----------------|------------|------------|-----------|-----------|
| Price (Rp)     | 1500       | 20.000     | 1500-2500 | 7000      |
| Demand (t/month) | 340        | 385        | 200-500   | 5         |
| Supply (t/month) | 100        | 18         |           | (wild beneng) |
| Market opportunity (t/month) | 322        | 25         |           |           |

Source: interview from the Beneng Association (Asputaben) [16]
3.3. Production, Development and Export Opportunities

Production of Beneng varieties varies between farmers, depending on environmental factors and cultivation methods. Environmental factors such as land fertility and water availability. Meanwhile, plant cultivation such as application of fertilizer, the spacing of plant, seedling, and plant maintenance. Spacing greatly affects productivity, in general, spacing is related to cropping patterns. The intercropping system is more common compared to the monoculture system. Intercropping system that planting Beneng under main crops. Monoculture system pattern is generally arranged in gardens with Beneng as the main crop, commonly the spacing consists of 1 m x 1 m (the total plants 10,000 plants/ha). The population of plants in intercropping is lower than in monocultures with the number of plants less than 8000 plants/ha. Meanwhile, with a monoculture system, the plant population ranges from 600-8000 plants/ha.

Fertilization also greatly affects production, especially organic fertilizers which have a major effect on soil fertility, texture, and structure. The fertility of the soil with a high of organic fertilizer will result in higher production. On fertile soils with a harvest period of 6 - 8 months, seedlings from weevils can produce up to 4 kg/plant and seedlings from tillers up to 2 kg/plant. Based on the data, the potential for Beneng production at the harvest period of 8-12 months can reach 1 - 4 kg/plant and in the harvesting phase 12-24 months the tuber weight can reach more than 15 kg/plant.

The seedling also has an effect on production, the seeds from the weevil leftover from the harvest will generally grow faster and have tubers than those from tillers. At the harvest age of 8-12 months, boggol seedlings will be able to produce between 2 - 3 kg/plant while those from tillers only range from 0.7 - 1 kg/plant.

![Arable Area (ha)](chart.png)

**Figure 1.** opportunities for demand dry leaves, fresh leaves and fresh tubers in the next five years

Export demand per month is 40 tons, the total requirement per year is 480 tons. On the other hand, leaf production per tree is 2 kg for 10 months with an estimated population/ha of 5000 trees (intercropping), so the prediction of the minimum land area is 384 Ha. This is to maintain the availability of dried Beneng leaves continuously. opportunities for demand for dry leaves, fresh leaves and fresh tubers in the next five years (figure 1).

The total planting area for Beneng in Banten Province in 2020 is 263 ha. The minimum land area requirement for continuity of production/year is 384 ha. The difference between the existing and development potentials is 121 ha so that the estimated need for seedlings for the development of 605 seedlings/tree.

According to the farmers and Asputaben management, the export demand for dry leaves, fresh tubers and cassava flour consecutively reached 340 t/month, 370 t/month and 100 t/month for Australia, Malaysia, the Netherlands, India, Turkey, New Zealand and South Korea [16]. In addition, domestic demand is lower but continues to increase (Table 7). Beneng leaves contain tannins with a yield of 3448.20 mg/kg [12]. This shows the potential for Beneng taro leaves to be used as a biopesticide.
Table 4. Distribution of area and existing planting area of Talas Beneng Banten in 2020

| District          | Planted Area (ha) | District          | Planted Area (ha) | District          | Planted Area (ha) |
|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Majasari          | 15                | Cileles           | 10                | Ciomas            | 35                |
| Kaduhejo          | 50                | Gunungkencana     | 7                 | Sasahan           | 7                 |
| Cisata            | 13                | Muncang           | 2                 | Palima            | 5                 |
| Jiput             | 7                 |                   |                   |                   |                   |
| Menes             | 12                |                   |                   |                   |                   |
| Karang tanjung    | 35                |                   |                   |                   |                   |
| Cadasari          | 25                |                   |                   |                   |                   |
| Banjar            | 3                 |                   |                   |                   |                   |
| Cipeucang         | 3                 |                   |                   |                   |                   |
| Cibaliung         | 8                 |                   |                   |                   |                   |
| Carita            | 6                 |                   |                   |                   |                   |
| Mandalawangi      | 20                |                   |                   |                   |                   |
| **Total**         | **197**           |                   |                   |                   |                   |

Sources: Agriculture Agency of Pandeglang District [15]

Table 5. Export Demand Opportunities to other countries

| Country        | Dry leaves (t/month) | fresh tubers (t/month) | flour (t/month) |
|----------------|----------------------|------------------------|-----------------|
| Australia      | 200                  | -                      | -               |
| Netherlands    | -                    | 70                     | -               |
| Malaysia       | 40                   | -                      | -               |
| India          | -                    | -                      | 50              |
| Turkey         | -                    | -                      | 50              |
| New Zealand    | 100                  | -                      | -               |
| South Korea    | -                    | 300                    | -               |

Source: interview from the Beneng Association (Asputaben) [16]

Table 6. Local demands market

| Market          | Fresh tuber (t/month) | Flour (t/month) |
|-----------------|-----------------------|-----------------|
| Bekasi          | 8                     | -               |
| Sukabumi        | 7                     | -               |
| Saung Talas- Bogor | -                    | 24              |
| Semarang        | 300                   | -               |
| Bekasi          | 8                     | -               |

Source: interview from the Beneng Association (Asputaben) [16]

4. Conclusion

The morphological character of the Beneng varieties has the characteristics of its origin in Juhut, that is large tuber size (giant tuber), the yellowing color of tubers, high oxalic acid content, and shade resistance. The potential marketing of Beneng’s is very high for both local or domestic markets and export markets. The type of demand is not only for fresh tubers but also in the form of chopped dry leaves and flour, cassava and chips. The high oxalate content is one of the attractions for marketing abroad. High market opportunities accompanied by support from central and regional governments as well as farmers make Beneng a national superior taro variety that is prospective to be developed in the future.

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