Morphological characteristics of Madiun 1, the First Porang (*Amorphophallus muelleri* Blume) released cultivar in Indonesia

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**Abstract.** Porang (*Amorphophallus muelleri* Blume) is a tuber crop native to the tropics that belongs to the Araceae family. Porang is a potential tuber crop that has been known in Indonesia for a long time, but the value of its product has not been widely disclosed. The planting area covers over 45,000 ha with East Java as the main production area. Madiun-East Java has a long and the oldest history of porang cultivation in Indonesia and has great potential for porang development. Characterized and officially released its local cultivar as an official released cultivar would protect the local germplasm and can be used as a basis for character improvement. Porang Madiun 1 cultivar has morphological characteristics of compound leaf type, dark green-green leaf color. The color of the leaf edges is pink, but as the age of the plant increases, the leaf edges turn white. Porang leaf surface smooth-wavy, hairless. The edges of porang leaves are smooth-wavy, depend on sunlight intensity. Stem shape was round, stem color was green with white spots and longitudinal lines, The pattern of spots on the stems has a sparse density, with the color of the stems varying depending on the age of the plant. Shape of bulbil was irregular round with various size. Average corm weight of Madiun 1 was 0.1 kg for first year porang plant, 0.4 kg for second year porang plant, and 1.6 kg for third year it became 1.6 kg with the average number of bulbils 1.8, 4.9, and 16.7, respectively.

1. **Introduction**

Various tubers are potential sources of carbohydrates to be developed as an alternative to staple foods other than rice and corn. In addition to tubers and sweet potatoes, other types of tubers that have the potential to be developed are porang (*Amorphophallus muelleri* Blume), uwi (*Dioscorea alata*), bentul (*Colocasia esculenta*), arrowroot (*Maranta arundinacea*), canna (*Canna edulis*), kimpul (*Xanthosoma violaceum*), and suweg (*Amorphophalus campanulatus*).

Porang (*A. muelleri* Blume) is a potential tuber crops that has been known in Indonesia for a long time, but the value of its product has not been widely disclosed. Porang is a tuber crop native to the tropics that belongs to the Araceae family [1,2]. According to [3], as an alternative food ingredient, porang products that are commonly processed and marketed from fresh corms are chips, porang flour (konjac flour) and glucomannan flour (konjac glucomannan). According to [4] flour from this corm contains up to 75% glucomannan (a natural soluble fiber derived from carbohydrates/polysaccharides which are very good for health), higher than that found in other corms such as *A. konjac* and *A.
Based on viscosity and transparency quality of the colloid solution, *A. muelleri* is the most suitable species to be planted in a large area scale [5].

Porang can be used as raw material for the food and non-food industries. In the food industry, porang is usually processed first into mannan flour. Glucomannan from *A. konjac* in Japan is used as a raw material for making konyaku and oden (Japanese food). In addition to food ingredients, glucomannan has been widely used as a raw material for the slimming drug industry, edible wrappers and drug fillers because of its special colloidal properties with low energy content [6]. The flour can be modified into various processed food products such as meatballs, chips, pastries, noodles (shirataki), rengginang, and tofu (konyaku). In addition, porang corms can be used in the cosmetic, textile, and medicine industries [7]. Sufiani [8] added that the use of porang in the non-food industry can be distinguished based on three criteria: a) on the basis of its adhesion, porang is used for the cosmetic industry, namely for thickening creams; b) based on its chemical properties, used for the film and celluloid industry; c) based on its impermeable nature, it is used for making tents, raincoats, umbrellas and others.

Considering the high economic potential value of porang, many people are interested in cultivating it in the agroforestry system (agroforestry), as a secondary crop under teak, mahogany, or rosewood plantations on Perum Perhutani land [9]. Agroforestry conditions with 50-60% shade are suitable for porang growth [1], in certain cases it still can produced corms at 75% shading intensity [10].

Porang production still does not meet local and international market standards (Japan, China, Taiwan, Korea, Europe, and Canada) which reaches 9000 tons of wet corms and 1000 tons of dry bulbs per year. The PKKP Center [11] reports an average porang productivity of 6-12 tons ha-1 of wet corms. Sugiyama and Santos [6] stated that the potential for porang production is >40 tons ha-1. The low productivity of plants is caused by several things including: 1) the low genetic potential of existing plant clones, 2) cultivation techniques that are still not intensive and still depend on natural harvests and 3) lack of understanding of the right harvest time. This is in line with Suryadi statement in [13], varying corm sizes resulted in corm weight less than 1 kg and only 4 tons of wet corms per hectare of planting. Inconsistency in porang production is related to genetic variation and environmental conditions in which porang grows.

Porang is an apomixis plant, where the formation of seeds without going through pollination [1]. However, [13] reported the presence of morphological diversity. The implication is that breeding of new varieties can be achieved through clonal selection with high production characteristics.

Porang in Madiun has long been known, namely since the 1970s. Within the year, the farmers sold porang corms to Nganjuk, the neighboring regency, where collective trader porang corms are found. At first the porang plant grew wild in the forest area of Mount Pandan. According to the story of Mr. Mulud (85 years) an elder in Klangon Village, porang that are developing in his village at this time are porang which come from the forest and grow wild, then are cultivated on land under tree stands in the Perhutani area. Porang began to be cultivated in Klangon and Pajajaran Villages, Saradan District in the 1980s and porang cultivation in Klangon Village was earlier than the surrounding villages. Klangon is a village administratively included in the Saradan District, Madiun Regency.

The challenge in developing porang is that no released varieties have been released so that improvements in cultivation techniques and development programs by the government are constrained by these conditions. The protection of porang from Klangon Village, Saradan District, Madiun Regency is considered important and strategic as a geographical indicator and a lever for the development of Indonesian porang.

The aim of this paper is to characterize porang Madiun 1 variety under in situ condition, in Klangon, Madiun.

### 2. Materials and Methods

Characterization of porang Madiun 1 cultivar was carried out in-situ, i.e. in Klangon village, Saradan district, Madiun Regency during the growth cycle of the plant, i.e. November 2019-August 2020. In-situ characterization was carried out using farmers' cultivation methods on forest stands. It was carried
out in three locations in Klangon Village. At each location an observation plot area of 10 x 10 m² is determined. In each plot, 30 sample plants were observed, consisting of plants from the first year, second year, and third year, each with 10 plants. So the total sample amounted to 90 plants. Characteristics of observation locations are presented in Table 1. Observations include morphological characteristics of porang plants consisting of leaves, stems, flowers, bulbil, and corm referring to [14]. Characterization carried out at two month after seedling leaf fully opened and at bulbil and corm harvest. Bulbil were harvested at 4-5 months after seedling, corms were harvested 6 weeks after the plant begins to turn yellow (*ripah*).

### Table 1. Location for characterization of porang (*Amorphophallus muelleri* Blume). Klangon, Saradan, Madiun, 2020

| Location | Ordinate | Altitude (m asl) | Light intensity (lux) |
|----------|----------|------------------|----------------------|
| A        | -7°28'34", 111°47'45" | 474 | 20,20 |
| B        | -7°28'12", 111°47'36" | 538 | 24,09 |
| C        | -7°28'11", 111°47'36" | 527 | 46,95 |

Note: 1)m asl stand for meter above sea level

### 3. Results and Discussion

The main economic value of porang plants are bulbil and corm. Bulbils are used as planting material, while corms are not only used as food and industrial raw materials, they are also used as planting material. Porang plants begin to grow at the beginning of the rainy season by utilizing food reserves stored in corms and bulbils to start vegetative growth such as leaves, stems, and fruit. After complete vegetative growth, corm growth begins until the plant begins to turn yellow (*ripah*), and then the plant will experience a dormant period until the beginning of the next rainy season to start the next year's growth period (second year, or third year).

Porang leaf surface of Madiun 1 was smooth-wavy, hairless. The shape of the porang leaf edges is thought to be influenced by light intensity. When shaded, the edges of the porang leaves were smooth-slightly wavy, but if they get more sunlight or higher light intensity, the edges of the porang leaves became wavy (Figure 1). Stem shape was round, stem color was green with white spots and longitudinal lines, leaf type was compound, leaf color was green, Leaf blade shape was elliptical pointed tip, edge color of young leaves was pink, old leaf edge color was white.

![Figure 1](characteristics_of_porang_leaf_edges_in_klangon_madiun_2020.jpg)

Porang stem has a unique stem pattern. There were three stem patterns found in the porang plantain in Klangon, namely pattern A, pattern B, and pattern C (Figure 2). The stem pattern of pattern C was
the majority in the three in situ characterization sampling areas. Within pattern C itself there was a fairly high variation as has been reported by several researchers [1]; [15]; [16].

In the first year, the stems of porang are light green evenly from the base of the stem to the stalks, however, over time the color of the stem changes to two conditions, i.e., turn into a gradation with dark green at the base and light green above, and homogenous dark green. Porang in the Klangon area is also unique with the presence of longitudinal lines such as in pattern C. The presence of lines on the stem can be seen clearly in the second- and third-year plants.

Morphological and agronomic performances of porang in Madiun at the age of 2 months presented in Table 2. Plant height, stem diameter, petiole length, leaf width, and canopy width were different between the first-, second-, and third-year plants. Those characteristic differences among plant’s age were also reported by other researches [16]; [10]. At the age of two months, the prospective bulbil that are formed were already visible.

| Character                | First year | Second year | Third year |
|-------------------------|------------|-------------|------------|
| Plant height (cm)       | 47.2       | 80.8        | 110.9      |
| Stem length (cm)        | 3.6        | 8.6         | 16.1       |
| Leaf length (cm)        | 20.1       | 33.7        | 52.0       |
| Leaf width (cm)         | 6.5        | 7.4         | 8.3        |
| Number of leaf axils    | 9.8        | 36.5        | 86.9       |
| Canopy width (cm)       | 40.9       | 75.2        | 125.4      |
| Stem diameter (mm)      | 13.0       | 26.5        | 51.0       |
| Super bulbil diameter (mm) | 13.2      | 17.1        | 21.7       |

Bulbil emerge from leaf axils, but not all leaf axils are productive and give rise to bulbil. Shape of bulbil was irregular round with various size, the outer color of the bulbil was brown while the flesh colour was light brown.

The size and number of bulbils produced increased in the second- and third-year plant growth periods (Table 3). In the characterization carried out on porang plants aged 2 months, the bulbils were already formed and the number of bulbils in the third- year plants was more than the number of bulbils.
in the second-year plants. The number of bulbils has the potential to increase and get bigger in the three years of plant growth. Bulbils emerge from the leaf axils, but not all bulbils emerge from the leaf axils. The results of the characterization of local porang plants in Madiun 1 in the first, second, and third years showed that the number of bulbils produced increased by 2, 5, and 16, respectively (Table 3). The size of the bulbil produced varies according to the position on the leaves, the farther from the main branch the smaller the size in each period of the plant. The number of corms and the number of bulbil produced also varied, depending on the first, second, and third year crop periods (Figure 2).

Table 3. Average weight of bulbil and porang (*Amorphophallus muelleri* Blume) corms in Madiun, 2020

| Characters              | First year       | Second year      | Third year       |
|-------------------------|------------------|------------------|------------------|
| Number of bulbil        | 1.8 (1.3-2.6)    | 4.9 (3.5-6.5)    | 16.7 (15-19.1)   |
| Bulbil weight (g)       | 3.5 (2.9-3.9)    | 14.4 (10.5-16.9) | 43.4 (28.9-53.5) |
| Super bulbil diameter(mm)| 18.7 (18.2-19.1)| 28.1 (26.6-28.8)| 37.1 (35-38.4)   |
| Shortest corm diameter (cm)| 9.4 (8.7-10.5)   | 14.2 (13.5-14.5)| 22.6 (21.9-23.9) |
| Diameter of the longest corm (cm)| 10.1 (9.4-11)   | 15.1 (14.1-15.8)| 23.7 (21.9-23.9) |
| Bulbil height (cm)      | 7.4 (6.8-8.2)    | 11.2 (10.7-11.4)| 15.7 (15.5-16)   |
| Bulbil weight (kg)      | 0.1 (0.1-0.15)   | 0.4 (0.3-0.5)    | 1.6 (1.5-1.8)    |

Figure 3. Performance of corms and bulbil in three growth periods (first, second and third year). Klangon, Saradan, Madiun 2020

Porang corms produced vary in size depending on the planting material, growth period (first, second, third year), and the age of the plant. In the first year of planting at the age of 1 month, the corms have not yet formed. In the second and third years of planting, the average corm weight was 48.3 g and 162.1 g, respectively. In the first year the average corm weight was 0.1 kg, in the second year it increased to 0.4 kg and in the third year to 1.6 kg (Table 3). Budiman [12] stated that to meet market quality standards, porang harvesting is carried out after the corm diameter is more than 15 cm and the minimum weight is 1-2 kg. According to [10];[14] the wider the diameter, the greater the corm weight and the higher the glucomannan content. Therefore, corm diameter can be used as one of the
morphological characters that is used as a reference for porang harvest. Corm flesh colour of the observed accession was orange.

Madiun 1 is the first released porang cultivar in Indonesia. Releasing the local Madiun cultivar as an officially released cultivar would protect the local germplasm and the characters’ information is useful for character improvement.

4. Conclusion
Porang Madiun 1 cultivar has morphological characteristics of compound leaf type, dark green-green leaf color. The color of the leaf edges is pink, but as the age of the plant increases, the leaf edges turn white. Porang leaf surface smooth-wavy, hairless. The edges of porang leaves are smooth-wavy, depend on sunlight intensity. Stem shape was round, stem color was green with white spots and longitudinal lines. The pattern of spots on the stems has a sparse density, with the color of the stems varying depending on the age of the plant. Shape of bulbil was irregular round with various size. Average corm weight of Madiun 1 was 0.1 kg for first year porang plant, 0.4 kg for second year porang plant, and 1.6 kg for third year it became 1.6 kg with the average number of bulbil 1.8, 4.9, and 16.7, respectively.

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