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Ethnobotany of *Amorphophallus muelleri* var. Madiun I: Culture and Nutraceutical Study in Klangon Village of Madiun Regency, Indonesia

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ABSTRAK

Desa Klangon, Kecamatan Saradan di Kabupaten Madiun merupakan salah satu desa penghasil porang terbesar di Indonesia dengan hasil kualitas ekspor sehingga menjadi salah satu desa Sentra Porang. Budidaya porang dipercaya dilakukan secara turun temurun dalam sistem agroforestri. Penelitian ini bertujuan untuk mengungkap lebih banyak peran porang bagi masyarakat Desa Klangon, baik dari segi budaya dan hubungannya dengan kandungan fitokimia porang. Penelitian dilakukan dengan cara observasi, pengambilan data etnobotani, pengambilan data fitokimia sebagai nutrasetikal, dan analisis data. Pengambilan data fitokimia dengan spektrofotometri sedangkan data spasial menggunakan aplikasi GPS Essentials. Analisis etnobotani dilakukan dengan Cultural Significance Index (CSI). Analisis nutrasetikal dengan menguji kandungan vitamin-vitamin melalui metode spektrofotometri. Disimpulkan bahwa studi etnobotani menunjukkan hasil CSI tertinggi pada tanaman porang dan studi nutasetikal pada tanaman porang menunjukkan keberadaan antioksidan (vitamin E), vitamins B1, dan B6.

***Kata kunci*:** *Amorphopallus muelleri*, etnobotani, nutrasetikal, Desa Klangon, spektrofotometri

ABSTRACT

Klangon Village, Saradan District in Madiun Regency is one of the largest porang-producing villages in Indonesia with export quality results, making it one of the Porang Center villages. Porang cultivation is believed to have been carried out from generation to generation in an agroforestry system. This study aims to reveal more about the role of porang for the people of Klangon Village, both in terms of culture and its relationship to the phytochemical content of porang. The study was conducted through observation, ethnobotanical data collection, phytochemical data collection as nutraceuticals, and data analysis. Phytochemical data was collected using spectrophotometry while spatial data was collected using the GPS Essentials application. Ethnobotanical analysis was carried out using the Cultural Significance Index (CSI). Nutraceutical analysis by testing the content of vitamins using the spectrophotometric method. It was concluded that Ethnobotanical studies of porang plants show the highest CSI values in porang plants and nutraceutical studies of porang show the content of antioxidants (vitamin E), vitamins B1, and B6.

***Keywords*:** *Amorphopallus muelleri*, ethnobotany, nutraceutical, Klangon village, spectrophotometry

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1. INTRODUCTION

Porang (Indonesian), known as *Amorphopallus muelleri* is an endemic plant of Indonesia. The second largest producer of porang in Indonesia, after Bali is Madiun Regency in East Java Province. Even the porang produced from Madiun is a special variety, namely Madiun I. Madiun Regency also has a vast forest area. The kinds of forests are protected forests and production forests. The forest used for the people is a production forest, reaching 68.8 million Ha (Ministry of Environment and Forestry, 2024). Forests are needed to support the life of the porang, which only grows optimally understory/ shade of trees. Therefore, since ancient times, the agroforestry system has been very well maintained for porang and other shade plants such as rhizome and coffee plants. Porang plants are a type of plant from the Araceae family group that is spread across South and Southeast Asia, starting from India, Myanmar, Thailand, and Indonesia. This plant grows easily in tropical areas and is an annual plant. The average height varies from 1 m to 1.5 m (da Cruz et al., 2024). The flower is unisexual, flowering after 3 to 4 years, then the tubers can be harvested (Santosa *et al*., 2018).

In Madiun Regency, there are also 5 sub-districts known as Porang Centers, one of which is Klangon Village in Saradan District. The village is located at the foot of Mount Pandan. Previously, Klangon Village was classified as an Underdeveloped Village Presidential Instruction / Inpres Desa Tertinggal (IDT), or in the category of poor villages (Hamdhan, 2020). Still, the welfare of the community began to increase since the price of porang products, which are export commodities, soared. Porang tubers are widely used as raw materials for food, cosmetics, and the medical industries, and have become high-value export commodities. Based on information from the official website of the Indonesian Ministry of Industry, in 2020, porang tuber production in Indonesia reached 142,000 tons from an area of 19,950 Ha, and it is planned that in 2024, porang tuber production can reach 600,000 tons from an area of 100,000 Ha (Kemenperin, 2022). Porang tubers are often exported in the form of chips or thin slices (Rahayoe et al., 2025). Porang exports from January to July 28th, 2020, reached 14,568 tons worth IDR 801.24 billion (Rahayuningsih, 2020).

Ethnobotany is a science that studies the relationship between humans and plants. In this case, the importance of plants for human life is studied in depth to understand the various benefits in the daily lives of local communities in an area. The benefits in question are knowledge passed down from ancestors (Kumar et al., 2021). The specific geographical conditions in an area certainly affect the types of plants that can live in that area. Another factor that affects the diversity of plant species in an area is the level of priority of the community's needs for certain plants, so that they will plant plants that suit their needs. Ethnobotanical studies provide information on how local communities cultivate and conserve certain plants by preserving their ancestral culture. Porang plant cultivation in Klangon Village is carried out using an agroforestry system. The application of this system is not only carried out to meet the needs of an ideal place to live for porang, but it is also able to preserve the types of stands in the forest. The types of stands that commonly shade porang in Klangon Village are teak and rosewood (Nugrahaeni et al., 2021). To determine the influence of porang plants on local culture, several ethnobotanical analyses can be carried out, one of which is the Cultural Significance Index (CSI). CSI uses a major and minor approach to the benefits of plants assessed by correspondents. Analysis in this way is certainly based on subjective values, therefore, in 2006, Silva et al. added a correction factor (CF) to reduce the level of subjectivity (Hakim, 2021).

Nutraceutical is a combined term of nutrition and pharmacy. In this study, a plant can be known for its benefits as food or medicine. Plants can be directly utilized in whole or in part, directly or through prior processing (Mishra *et al*., 2022). Currently, utilization as medicine only takes active compounds from certain plants with sophisticated equipment, wether in ancient times plants had to be processed in such a way that it took time and energy and had to follow hereditary recipes. The term "smart person" in the past also referred to people who were experts in concocting plants and could distinguish between poisons and medicines so that the local community trusted their knowledge. The benefits of porang in terms of nutraceuticals are certainly inseparable from what is contained in it, called its phytochemicals. Useful ingredients can come from primary or secondary metabolite compounds. Porang tubers contain carbohydrates, proteins, phenolics, and a little saponin (Putri *et al*., 2022). Porang tubers are also known to have a glucomannan content, or what is commonly known as KGB (Konjac Glucomannan), of 35,8% with water solvent (Sholichah et al., 2023) and 96,35% with an ethanol solvent (Azhar et al., 2023). In addition to glucomannan, porang plants generally also contain antioxidants (Bhuvaneswari & Sivasubramanian, 2023), which are compounds that counteract free radicals that damage body cells (Zhong *et al*., 2017), and polyphenols, to prevent cancer, heart disease, and diabetes. It is also rich in carbohydrates, protein, and a little saponins (Putri *et al*., 2022). Some food products that contain processed porang are jelly powder, konjac, shirataki rice, shirataki noodles, meatballs, sausages, bread products, ice cream, and chocolate.

Porang and rhizomes are cultivated in agroforestry in production forests with a conventional planting concept. Agroforestry plant cultivation greatly supports the sustainability of tree plants in production forests (Puspita *et al*., 2021). This type of cultivation allows tree plants to coexist with horticultural plants that require shade, such as porang (Dewi *et al*., 2021), rhizomes (Sarkar *et al*., 2024), and coffee (Hakim, 2021). In addition to functioning as shade, these tree plants can be harvested at a certain age to be sold or processed into charcoal. In Klangon Village, ethnobotanical studies of porang plants in agroforestry systems have never been conducted. Previous studies on porang cultivation in Klangon Village had not explored the ethnobotanical aspects within its agroforestry systems, particularly the cultural and nutraceutical relationship. Therefore, research on ethnobotanical porang (*Amorphophallus muelleri* var. Madiun I) in agroforestry systems, especially nutraceutical and cultural studies at the Porang Center, Klangon Village, Saradan District, needs to be conducted. While general *Amorphophallus* species have been studied, there has been no extensive review or study focused on the Madiun I variety's specific phytochemical content, especially vitamins.

The research provides a substantial contribution to both ethnobotany and tropical nutraceutical studies. As in ethnobotanical view, this applies the Cultural Significance Index (CSI) to quantitatively show the high importance of porang to the local community in Klangon Village, a major porang production center in Indonesia. It documents the local

wisdom of cultivating porang in an agroforestry system with specific shade trees and demonstrating how this practice also aids forest conservation. Meanwhile, nutraceuticals study offers novel data on the phytochemical composition of the Madiun I variety. The research explore the potential of this specific local variety as a valuable source of natural nutraceutical compounds, which can be used in the food, cosmetic, and medical industries.

2. RESEARCH METHOD

The research began in July 2023 until May 2024. Ethnobotany research took place in Klangon Village, Saradan District, Madiun Regency in 4 hamlets, namely Klangon, Bandungan, Sempol, and Pohulung. For cultural studies in the case of ethnobotany research, the tools needed were writing instruments, a camera, and GPS. Spatial data were collected to determine the location of porang and porang cultivation gathering points. Spatial data were obtained using the GPS Essentials application.

The study's limitations were primarily related to methodological design, geographical scope, and sampling approach. The research method used to obtain data is non-probability sampling, namely by deliberately selecting a place, namely Klangon Village as a research location (Albuquerque et al., 2014). The data collection location was chosen randomly, where 5 hamlets were selected from one village. The selection of the location was also based on information from the service office in Klangon Village to provide information about the hamlets that contribute the most porang. By purposive sampling, the selected hamlet head will be the key person or key informant who will appoint several of his residents with the following conditions: being a native resident, having or planting porang plants on his land or someone else's land, and knowing its benefits, not planting porang but knowing its benefits, or being over 40 years old, at least 20 years to obtain more objective information regarding local wisdom in porang plant cultivation (ethno-agronomy).

If there is a customary authority, that person can also be used as a key person. Information from each sample was obtained by conducting semi-structured interviews. The information expected to be obtained by researchers is the location where porang is planted (position and type of shade), the benefits of porang, and which parts of the plant are used. Through field observations, data was obtained on other plants that also grow beside porang in the agroforestry system. This information will then be analyzed using the cultural significance index (CSI). CSI is used to determine the extent of the influence of a species on the lives of local people. The higher the CSI value, the greater the species' influence on the local community's culture. CSI formula (Da Silva et al., 2006):

$$CSI = \Sigma(i \times e \times c) \times CF$$

Description:

i = species management (value 1: not managed, value 2: managed)
e = usage preference (value 1: disliked, value 2: preferred)
c = usage frequency (value 1: rarely, value 2: often)
CF = number of citations of a particular species divided by the highest citation of all observed species

The study focused exclusively on the Amorphophallus muelleri var. Madiun I from Klangon Village. The results may not be generalizable to other porang varieties found in different regions of Indonesia or globally. The nutraceutical analysis only examined specific vitamins in the tubers, a more comprehensive analysis of all phytochemicals was outside the scope of this particular study. Data collection occurred during the dry season, which influenced the climate observations and the ideal harvest time for other medicinal plants (rhizomes) in the area. Porang plants were generally left to grow without standardized fertilization or care unless prices were high, which might affect the consistency of the phytochemical properties across different growing cycles or conditions.

2.1. Nutraceutical Study

2.1.1. Determination of Vitamin A and E

The amount of 4 mg porang sample was added with ethanol and mixed with 2.5 oleic acids in 99.5% ethanol (4.1 mL), 0.05 M phosphate buffer, pH 7 (8 mL), and stored in a closed container in the dark at 40˚C. Then for every 0.1 mL of this solution, 9.7 mL of 99.5% ethanol and 0.1 mL of 30% ammonium thiocyanate were added. After 3 minutes, 0.1 mL of 2M ferrous chloride in 3.5% HCl was added to the solution, then the red color absorbance was measured at 500nm with spectrophotometry UV/Vis every 1 hour until the control absorbance reached its maximum. The control and standard received the same treatment, but the control did not need a sample. For the standard, 4 mg of the sample was replaced with ά- tocopherol or vitamin E and retinol for vitamin A (Espuelas et al., 2019). Repetition was done three times, then the average value was recorded.

2.1.2. Determination of Vitamin B1 and B6

A sample of 10 grams, was filtered, then the filtered results were added with distilled water and left at room temperature for ±1 hour. Thiamine standard at a wavelength of 400-700 nm. Determination of vitamin B1 levels in porang is done by putting 5 ml of sample filtrate into a 25 ml measuring flask, then adding 1.5 ml of ammonia buffer solution and 3 ml of 0.05% bromthymol blue indicator. Next, 1 ml of 1% polyvinyl alcohol and distilled water are added to the meniscus line limit and then homogenized. Measure the sample absorbance at a maximum wavelength of 511 nm with spectrophotometry UV/Vis by looking at the absorbance value (Rahmawati & Sa'diyah, 2020).

Determination of vitamin B6 (pyridoxine) levels at a wavelength of 254 nm (Rahman et al., 2021). Repetition was done three times, then the average value was recorded.

3. RESULT AND DISCUSSION

3.1. Landscape and Climate

Klangon Village is located in Saradan District, Madiun Regency, East Java Province. Its northern boundary is Mount Pandan, its eastern boundary is Nganjuk Regency, its southern boundary is Pajaran Village, and its western boundary is Sumberbendo Village. Geographically, this village is located between production forests and protected forests, making it a buffer forest village (Figure 1).

The climate tends to be dry even in hilly areas and the type of soil is slightly sandy dusty clay. The majority of the residents of Klangon Village are farmers, traders, laborers, and employees. The main agricultural products of this village are porang plants, followed by horticultural plants such as food and medicine. Data collection was carried out during the dry season so that the climate tends to be dry because rainfall is very low, based on data from the Meteorology, Climatology, and Geophysics Agency in June and July 2023 it was only around 20-50 mm/month. This climate was suitable for the harvest time of medicinal plants, especially from the rhizome type, because they usually require sunlight in the drying process of the harvest. Interviews were conducted with 34 respondents with an age range of 40-49 years old, 23.5%, 50-59 years old around 14.7%, 60-69 years old as many as 29.4%, 70-79 years old as many as 20.6% and 80-89 years old as many as 11.8%. Geographically their home must be located in 4 hamlets, namely Klangon, Bandungan, Sempol, and Pohulung, near the forest.

3.2. Culture Study Results

Local wisdom can be seen in terms of cultivation in forest areas which is not much different from cultivation in gardens or yards of villagers' houses. Based on interview results, only 25.71% of people know the history of porang, while those who did not know were 31.43%. (Figure 2). This interview also reveals that 89% of people plant porang in production forests, while 11% plant them in protected forests (Figure 3). Planting in production forests adopts a land rental system, where each land is valued per hectare, for one hectare it is valued at 1 million rupiah. Land rental payments can be made after harvest.

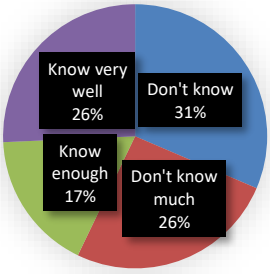
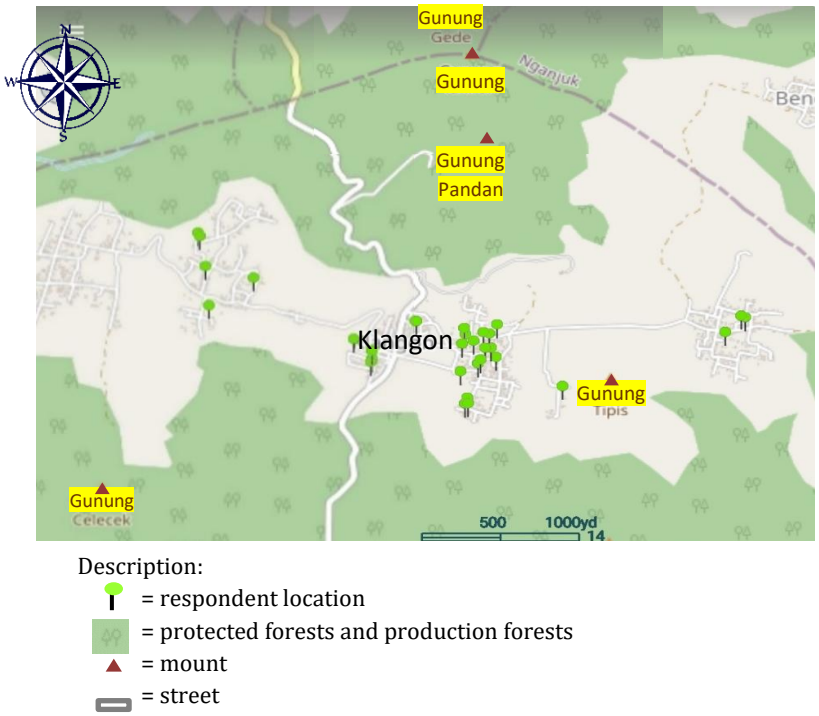


Figure 2. People Knowledge About the History of Porang



Description:
= respondent location
= protected forests and production forests
= mount
= street

Figure 1. Map of Research Location in Klangon Village

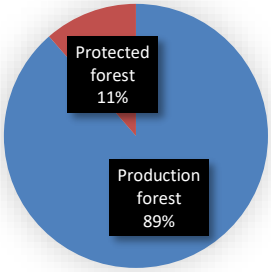


Figure 3. Porang Planting Location

The land rental period is calculated annually. As many as 52% of respondents chose to plant porang in the rainy season (Figure 4). This is done to reduce the cost of providing water in the early budding process of the vegetative phase of porang. The availability of rainwater can also provide moisture to the soil, thus providing an opportunity for decomposer microbes to prepare nutrients in the soil. As a plant that requires shade, porang is cultivated under various types of trees. The type of tree that is most in demand is the sono tree at 42% (Figure 5). This is because the sono tree wood harvest period is fast so the farming community can sell the wood directly. Sono trees are also used as charcoal when harvested. Shade can also be in the form of fruit trees, namely durian and avocado, so that the fruit can be an additional income for farmers. Other shade trees found are damarwulan/pridisiem, cassava, gondang, grontol, adem mati, lohlohan, gambiran, iprih, grasak, randu, and rudinem.

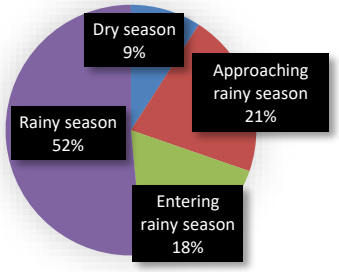


Figure 4. Planting Time of Porang

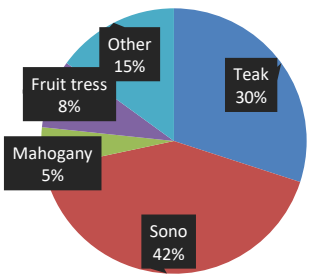


Figure 5. Percentage of Shade Types

Porang plant care is completely inorganic, with the reason to accelerate the enlargement of the tubers, but fertilization is only carried out when the price of porang is expensive. Outside of these conditions, porang tends to be left to grow without fertilizer. Harvesting is done conventionally where most of the treatment processes are slicing/chipping and drying (Figure 6).

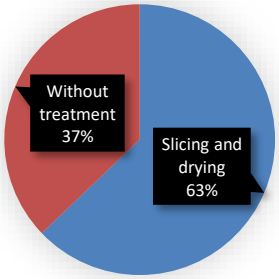


Figure 6. Post-Harvest Processing

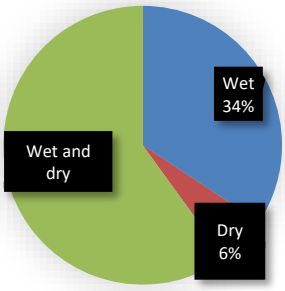


Figure 7. Status of Porang Tubers When Sold

Most respondents said that porang sales are carried out in wet and dry forms, depending on the price of porang, if it is cheap then porang is dried and sold when the price goes up (Figure 7). As many as 80% of respondents have known the benefits of porang after entering the industry and know how to process it, even though they have never processed it manually. They also said that they know the benefits of porang because of its vitamin and nutritional content. At the research location, 116 plant species were found that were utilized by the community from the food, horticultural, medicinal, and tree crops including porang. The highest CSI values of the top 20 were dominated by porang, food crops, and medicinal plants (Figure 8). This indicates how important these plants are for the agrarian culture of the Klangon Village community. Porang cultivation through agroforestry is dominated by teak and sono shade, indicating the high economic value of these plants which ultimately affect the topography of the forest on the mountain slopes. These agroforestry activities directly maintain forest conservation, both biotic and biotic elements in their ecosystems (Dermoredjo *et al*., 2021).

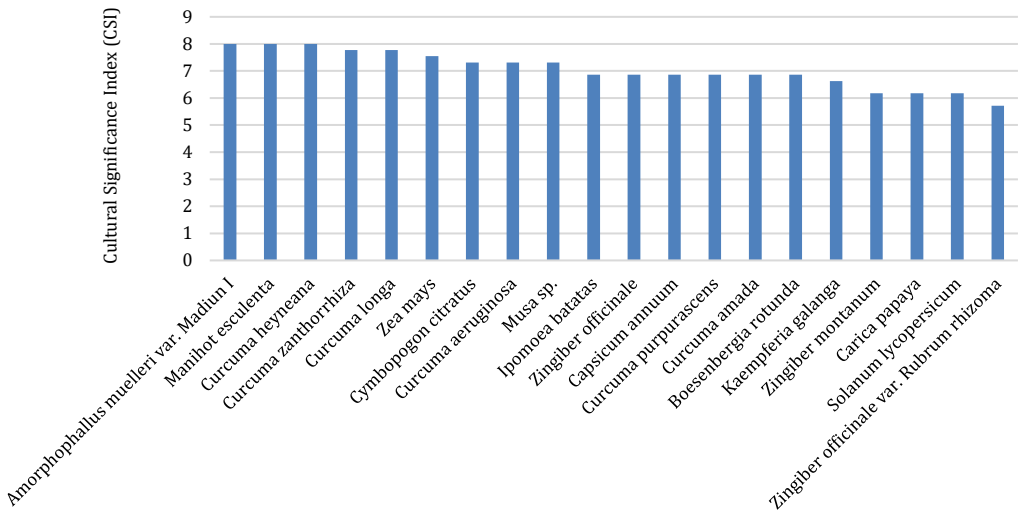


Figure 8. CSI Data on the 20 Highest Plants in Klangon Village

3.3. Nutraceutical Study Results

The results of the phytochemical analysis of porang tubers showed that the amount of antioxidant content was only vitamin E found in the sample. Vitamin E is generally found in plant tubers, although its production is not as high as antioxidants in leaves due to the additional combination of vitamins A and C (Georgiadou et al., 2020). Vitamin B is also generally found in plant tubers, especially in porang, vitamin B6 shows higher levels compared to B1 (Table 1).

Table 1. Phytochemistry Content of Porang's Tuber

Phytochemistry	Average Content/100 gram (ppm)
Antioxidant (Vitamin A)	0
Antioxidant (Vitamin E)	102
Vitamin B1	58
Vitamin B6	430

The results of this study indicate that the Madiun I variety of porang does not contain carotenoids, in contrast to the analysis test conducted by Pramudita *et al*. (2024) which showed that porang flour from *Amorphophallus muelleri* has a β-carotene content of 1.38 mg/100 g. Meanwhile, testing for vitamin E in porang tubers has never been studied, while other research has focused more on general antioxidants in porang leaves. Furthermore, testing the levels of thiamine and pyridoxine, which is new information in this study, provides additional evidence of the nutritional value of porang tubers. Unlike previous studies, porang was primarily studied for its glucomannan content and, to a lesser extent, for its vitamin content. The methods used to examine nutraceuticals, particularly vitamin levels, vary among researchers.

Table 2. Comparison of Previous Research on Porang Nutraceuticals

No.	Amorphophallus species	Vitamin content (reported)	Reference (author, year)
1	*Amorphophallus muelleri* (porang flour)	**β-carotene (provitamin A): 1.38 mg / 100 g** (≈ 13.8 ppm); other vitamins not quantified in that paper	Pramudita et al., 2024
2	*Amorphophallus muelleri* (porang leaves / general porang studies)	**Antioxidant activity reported**; studies focus on total antioxidant capacity and leaf extracts rather than standardized tuber vitamin ppm; vitamin E presence discussed as plant antioxidant class (no tuber E ppm given in many leaf studies)	Erikania & Rosalina, 2022
4	*Amorphophallus muelleri* (porang; processed product study)	**No quantitative vitamin values given;** authors report **high glucomannan and bioactive compounds/antioxidant potential,** but do not provide detailed vitamin data	Daysita et al., 2024
5	*Amorphophallus konjac* (review of konjac)	**Review notes the presence of antioxidant compounds and bioactive constituents across tissues;** vitamin quantification varies by study; **no single standardized quantitative vitamin dataset** presented	Jain et al., 2025
6	*Amorphophallus* spp. (macronutrient / tuber composition studies)	**Glucomannan, carbohydrates, proteins, fiber** emphasized; some macronutrient studies report general antioxidant presence but **do not** provide standardized vitamin A/E/B1/B6 ppm across varieties	Dari et al., 2021
7	*Amorphophallus* spp. (pharmacological / review)	**Authors summarize antioxidant and nutraceutical potential** (including vitamin-class antioxidants) but note **heterogeneity** in methods and units across studies — direct numeric vitamin comparisons are often missing	Isnaini et al., 2025
8	*Amorphophallus paeoniifolius* (elephant-foot yam)	**Phytochemical profiling reported;** study focused on general phytochemicals and standardization (HPLC/HPTLC); **vitamins not reported as quantified values** in the paper	Bhuvaneswari & Sivasubramanian, 2023

The plant part used for this purpose is the porang tuber. The high cultural significance index is directly related to the widespread use of the tuber for various purposes—food, cosmetics, and medicine—as cited by respondents, rather than simply the plant's general availability. The cultural-nutrition integration is emphasized by the finding that nutraceutical studies confirmed the presence of vitamins E, B1, and B6 in porang tubers, previously only known locally (as containing nutrients) based on inherited experiences. This traditional knowledge, including cultivation and initial processing (slicing/drying), directly facilitates the production of tubers scientifically proven to be nutrient-dense, thus linking cultural practices to nutritional benefits. Although the nutraceutical analysis in this study only tested for and identified a few vitamins, porang's high cultural value is explained by several factors beyond these specific vitamin contents: its economic value and export commodity, its role in agroforestry and conservation, and its use as an industrial raw material.

The high CSI value for the porang plant indicates its critical importance in the local culture, primarily for food, cosmetics, and medicine. This traditional valuation is scientifically supported by the nutraceutical analysis, which confirmed the presence of valuable antioxidants (vitamin E) and B vitamins (B1 and B6) in the Madiun I variety tubers. Most respondents in the study knew about the benefits of porang, attributing its value to its vitamin and nutritional content. The research confirmed these perceived benefits by identifying specific phytochemicals, effectively bridging the gap between anecdotal local knowledge and empirical evidence. The cultural practice of cultivating porang within an agroforestry system (a practice with a high CSI contribution) ensures the consistent production of this nutritionally dense tuber. This sustainable cultivation method, rooted in local wisdom, directly impacts the availability of a valuable nutraceutical source.

This nutrient-rich phytochemical composition demonstrates the great potential of the Madiun I variety of porang to be developed into a new functional food or dietary supplement. By incorporating these nutrient-rich components into the diet, functional foods and nutraceuticals play a vital role in promoting health and preventing disease. Bioactive compounds such as vitamins E and B can help fight free radicals, reduce the risk of chronic diseases like heart disease and cancer, and improve overall health. Utilizing porang as a source of nutraceuticals offers not only health benefits but also socio-economic advantages. It supports local agriculture, conserves biodiversity, and promotes sustainable development, particularly in rural communities like Klangon Village, a center for porang production.

4. CONCLUSION

Based on the research results, porang (*Amorphophallus muelleri* var. Madiun I) has the highest Cultural Significance Index (CSI) value, confirming its central role in the culture and agroforestry system of the Klangon Village community. It is also scientifically supported by the nutraceutical content of vitamins E, B1, and B6 in its tubers. These findings demonstrate a strong link between local wisdom, forest conservation, and porang's potential as a high-value functional food source. Further research is needed to explore the broader phytochemical spectrum and variations in porang's nutrient content under different ecological conditions and seasons.

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