Habitat characteristics and population of *Syzygium cumini* L. in private forest and customary forest of Yogyakarta

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**Abstract.** In the development of *Syzygium cumini* as a prospective commodity for pharmaceutical raw materials, information on habitat characteristics is required as a basis for technical suitability to land. The study aimed to determine the habitat and population characteristics of *S. cumini* in the private forest and customary forest. The population of *S. cumini* was grown in the field condition of the private forest and the customary forest in Yogyakarta Province. The sites of the plot samples were purposively chosen in a random following the standard method. The results showed that *S. cumini* trees were naturally grown at hilly/mountainous soil conditions, with a thin layer of soil, lots of rocks, and less fertile soil land based on the medium N, as well as low P and K contents. The trees were grown at an altitude below 500 meters above sea level, >1,000 mm year\(^{-1}\) rainfall, soil clay, the temperature of 25 °C to 30 °C, and mixed with other types of trees. The population of *S. cumini* trees in the private forest was 417 stands ha\(^{-1}\), higher than that of the customary forest (288 stands ha\(^{-1}\)). *S. cumini* has more potential to be secured its existence in customary forest and to be developed in private forest.

1. Introduction

Indonesia's tree biodiversity is experiencing a decline and destruction (20-70% of natural habitat) as a result of human activities with all their needs in exploiting forests [1]. The aftereffect of genetic erosion occurs at any time. The subsequent impact is a reduction in genetic resources at any time. One species of a medicinal plant that is becoming difficult to find in natural forest conditions is *S. cumini* (*Syzygium cumini* Linn). The distribution of *S. cumini* is highly diverse, ranged from Malaysia to northeastern Australia. The plant is grown in several parts of the continents of Asia, East Africa, South America, Madagascar, and Florida and Hawaii in the USA [2]. *S. cumini* is a multipurpose plant, but in Indonesia, it is only known as a fruit tree. The fruit contains protein, fat, carbohydrates, fiber, ash, calcium, phosphorus, iron, riboflavin, niacin, thiamine, and vitamin C [3]. Besides being consumed as fresh fruit, it can also be used as ingredients in traditional medicine, such as to cure blood sugar levels in India and Brazil [4]. Other studies showed that the seed extract could be used to treat various diseases, such as diabetes, hypoglycemic, anti-inflammatory, antioxidant, stress and genomic damage [5]. The fruit extract contains antioxidant and anticancer properties and could be used to delay nerve complications and cataract [6,7].

The suitable conditions for the growing *S. cumini* could be assessed by comparing its customary natural forest with that grown in the cultivated private forest. This approach will certainly be able to make decisions more quickly without conducting species testing. The existence of the *S. cumini* medicinal plant in Yogyakarta certainly can not always be applied in other areas. Therefore, it is
necessary to study the characteristics of the *S. cumini* habitat as a basis for determining the requirements for the physical environment conditions where it grows for development in other areas.

Habitat characteristics are the characteristics of the physical environment in which plants grow and reproduce. Certainly, *S. cumini* plant population is abundant in Yogyakarta because it is derived from natural seedlings from the mother tree that has existed naturally before. Unfortunately, many *S. cumini* plants have been replaced by other species that are considered more economically valuable crops; therefore, the growing population of *S. cumini* has become more challenging to find.

*S. cumini* could grow up to 15 m high and 75 cm in diameter [8]. It generally grows in lowlands below 500 m asl and marginal soils [8]. However, complete habitat information has not been widely reported. The study aimed to determine the characteristics of the growing place and population of *S. cumini* in the private forest and customary forests in Yogyakarta.

2. Materials and methods

2.1. Research location
The research locations were private forest in Triwidadi Village, Pajangan District, Bantul District, Yogyakarta Province and Wonosadi customary forest in Beji Village, Ngawen Sub-District, Gunungkidul District, Yogyakarta Province, Indonesia. Based on information from the private forest farmer, the two places could be found in the population of *S. cumini* trees.

2.2. Research procedure
Survey activities were carried out in the natural habitat of *S. cumini*. The plot sizes of 20 m x 20 m were purposively taken in both locations (the private forest of Triwidadi Village and Wonosadi Customary Forest). Soil samples were taken from both habitats at a depth of 30 cm and then chemically analyzed using the standard method [9]. The altitude location and soil temperature were taken from both locations. The population of *S. cumini* trees was taken by counting the stands of the trees. The diversity of tree vegetation species that were grown in both forests was assessed using the standard method [10]. The physical environmental conditions in the form of rainfall, altitude, temperature, and humidity were collected from the village monograph data and the Central of Regional Statistics [11]. Primary data were growth requirements, including soil, altitude, tree habitus, density, plant association, typology, geographic position, and topography. Secondary data were natural vegetation, soil types, climate, temperature, humidity, administrative areas, forest groups, watershed areas and collection of herbarium specimens.

2.3. Data analysis
Data analysis was carried out by describing the characteristics of the *S. cumini* habitat at both forest locations, starting from the characteristics of the soil, temperature, rainfall, humidity, altitude, and its relationship to the presence of the *S. cumini* population. Analysis of vegetation diversity data at habitat locations where *S. cumini* grown was carried out by calculating the Importance Value Index [10]. Soil samples were analyzed at the central laboratory for soil research at the UGM Faculty of Agriculture to determine pH, organic matter content, soil texture, and compare their chemical content with soil value levels [9].

3. Results and discussion

3.1. Habitat characteristics
*S. cumini* tree growth is relatively slow with bent trunks, roots, and spreading canopy (evergreens), and ripe fruit was blackish purple. *S. cumini* trees were sometimes bent, up to 15 m high and 75 cm in diameter [8]. Based on observations on the *S. cumini* private forest in Bantul Regency, Yogyakarta, the flowering season started in August, whereas in Bantul, Yogyakarta Province, began in September and
ended in February. The young fruit was pink and turned black when ripe. The soil characteristics of the S. cumini habitat in the two research locations were presented in table 1.

Table 1. Soil characteristics of the private and customary forest habitats of S. cumini.

| Location   | Texture (%) | pH | Org-Matter | N total | P Bray-1 | K available | CEC       |
|------------|-------------|----|------------|---------|----------|-------------|-----------|
|            | Clay | Sand | (1:5) | ----- | ppm | ----- | me 100 g⁻¹ |
| Bantul     | 67.79 | 16.93 | 6.72 | 3.96 | 0.22 | 5.37 | 0.32 | 50.56 |
| Gunungkidul| 51.41 | 2.67  | 5.28 | 4.27 | 0.21 | 2.82 | 0.24 | 34.81 |

The soil in both forest contained high clay that easily compacted and would interfere with plant growth. The level of soil acidity was a condition that allowed soil minerals to be absorbed by plant roots. The optimal pH values were 6.72 in Bantul and 5.28 in Gunungkidul that were quite suitable for plant growth since the required pH for S. cumini was 6.5 to 7. The content of organic matter in both forest types was relatively high, has the potential to become a carbon source, aggregate stability, ability to store water, became nutrients, increase CEC, reduce soil density, medium for the development of microorganism populations so that the more organic matter the soil becomes more fertile [12].

The available P and K contents were very low, while the total N content was medium, and the organic matter in both forests was high. Organic matter becomes a source for the formation of nutrients N, P, and S. In a mixed cropping pattern with decomposed litter organic matter. It is potentially improve the soil quality. Besides, the absorption of macronutrients by the slow-growing plant such as S. cumini was relatively slower than the fast-growing species such as albizia [13]. The CEC values found in the private and customary forests were very high to high. It means that the amount of charge adsorbed cations that could be exchanged from a soil mass under conditions of temperature, pressure, and composition of specific soil solutions. The CEC value could be used as an indicator of soil activeness in cation exchange; the higher the value, the higher the chances of receiving a fertilization response so that soil fertility increases. The soil textures in the two forests were also relatively the same, which were dominated by clay, whereas the CEC depends on clay content, various minerals, and organic matter [14].

Table 2. Physical environmental conditions of the private and customary forest habitats of S. cumini.

| Habitat indicators   | Physical environmental conditions                        | Habitat requirements for S. cumini                     |
|----------------------|----------------------------------------------------------|------------------------------------------------------|
|                      | Private forest in Bantul | Customary forest in Gunungkidul |                                                   |
| Type of soil         | Latosol         | Latosol/Grumosol        | Latosol, Aluvial dan Grumosol                      |
| Texture of soil      | Clay            | Clay silt               | Loam, sandy clay dan lime soil                     |
| Elevation            | 110 - 300 m asl | 400 m asl               | Optimally <500 m asl to 1,800 m asl                |
| Soil pH              | 6.72            | 5.28                    | -                                                    |
| Rainfall             | 1,200 mm year⁻¹ | 1,500 mm year⁻¹         | >1,000 mm year⁻¹                                   |
| Temperature          | 28-30 C         | 25-30 C                 | -                                                    |
| Patterns             | mix patterns    | mix patterns            | open area                                           |
| Landscape            | Hilly/mountainous, with a thin layer of soil, lots of rocks, less fertility | Land with low soil fertility [8] |
The area of Triwidadi Village was 1,430 ha, with the dominant landscape of hills and mountains (300 ha), and the rest was a flat area (130 ha). The Triwidadi private forest was located on the altitudes of 110 to 300 m above sea level (asl), rainfall above 1,200 mm year\(^{-1}\), and temperature ranged from 28 - 30 °C. The soil conditions were hilly/mountainous with lots of rocks and a thin layer of soil, dominant clay, and less fertile [11]. The Triwidadi land having fertile soil was 80 ha, medium fertile was 294 ha, and infertile was 56 ha [11]. *S. cumini* plant could be grown on marginal hilly soil [8].

Based on the information from Triwidadi Village people, the land has long been a habitat for *S. cumini*, which has grown naturally. It means that the *S. cumini* plant is not planted by the private forest farmer and grows naturally among other planted types, such as *T. grandis*, *A. mangium*, and *P. falcatoria*. In line with higher economic needs, farmers could manage the forest by replacing *S. cumini* with other plants types. The relatively small land ownership (<0.25 ha per family) made farmers manage their land using an agroforestry pattern. Therefore, it changes the structure of private forest vegetation, which results in the reduction of *S. cumini* vegetation.

*S. cumini* habitat was also found in Wonosadi Customary Forest in Beji Village, Karangngawen District, Bantul Regency, with about 240 to 400 masl, silty clay soil, rainfall above 1,500 mm year\(^{-1}\), temperature 25-30 °C in a mixed forest as presented in table 2. *S. cumini* plant distribution areas in Java were commonly in the middle altitude of 500 m asl [8].

### 3.2. Population of *S. cumini*

Based on the results of the survey on the *S. cumini* private forest, it shows that the diversity of vegetation types in the *S. cumini* habitat in the private forest consists of 10 families and ten species, as presented in table 4. The Shannon diversity index was H 1.404 or range between 1 and 3. It meant that the diversity of species was a moderate level, or the stability of the environmental conditions of the *S. cumini* habitat was relatively moderate. The total average amount of forest trees managed by the local people was 923 trees ha\(^{-1}\), of which were *S. cumini* (417 trees ha\(^{-1}\)). The INP ranks for five plant species were *Syzygium cumini* (158%), *Acacia auriculiformis* (44.2%), *Swietenia macrophylla* (41.28%), *Tectona grandis* (32.04%), and *Gnetum gnemon* (13, 83%).

### Table 3. Vegetation composition of *S. cumini* habitat in private forest in Triwidadi Village, Pajangan Sub District, Bantul District, Yogyakarta Province.

| No. | Species Name of Tree | Family           | \(\sum \) Stands ha\(^{-1}\) | \(K_r\) (%) | \(F_r\) (%) | \(D_r\) (%) | INP (%) | H'   |
|-----|----------------------|------------------|-----------------------------|------------|------------|------------|---------|------|
| 1   | *Acacia auriculiformis* | Fabaceae         | 133                         | 14.44      | 23.44      | 6.32       | 44.20   | 1.404 |
| 2   | *Pterocarpus indicus* Wild | Papilionaceae   | 2                           | 0.18       | 1.56       | 0.00       | 1.74    |       |
| 3   | *Tamarindus indicus* L | Caesalpinaceae   | 2                           | 0.18       | 1.56       | 0.00       | 1.74    |       |
| 4   | *Syzygium cumini*      | Myrtaceae        | 417                         | 45.13      | 23.44      | 89.43      | 158.00  |       |
| 5   | *Tectona grandis*      | Verbenaceae      | 105                         | 11.37      | 18.75      | 1.92       | 32.04   |       |
| 6   | *Cassia siamea* Lamk.  | Fabaceae         | 2                           | 0.18       | 1.56       | 0.00       | 1.74    |       |
| 7   | *Cocos nucifera* King. | Palmae           | 5                           | 0.54       | 3.13       | 0.01       | 3.68    |       |
| 8   | *Swietenia macrophylla* | Meliaceae      | 232                         | 25.09      | 14.06      | 2.13       | 41.28   |       |
| 9   | *Mangifera indica*     | Anacardiaceae    | 2                           | 0.18       | 1.56       | 0.00       | 1.74    |       |
| 10  | *Gnetum gnemon* L.     | Gnetaceae        | 25                          | 2.71       | 10.94      | 0.18       | 13.83   |       |

923 100 100 100 300

Notes: \(K_r\) (Relative Density), \(F_r\) (Relative Frequency), \(D_r\) (Dominance Relatif) and INP (Important Value Index), H (Shannon Winner Index) [13].
The diversity of the *S. cumini* habitat in the Wonosadi customary forest (2,308) was relatively higher than that of the *S. cumini* habitat in the private forest. Although the amount of vegetation in the Wonosadi customary forest is relatively the same, namely 933 vegetation ha\(^{-1}\), the number of wood species is higher. The vegetation composition of the *S. cumini* habitat in the Wonosadi customary forest has 21 species with 13 families. In fact, the number of species is almost comparable to the protected forest of Sesaot, West Lombok Regency, West Nusa Tenggara, which was recorded for 26-29 plant species [15]. The Wonosadi customary forest was relatively protected from logging, and the forest was relatively limited for foraging. The species with five of INP ranks in the *S. cumini* habitat in Wonosadi customary forest were *S. cumini* (123.5%), *Mischocarpus sundaicus* (41.45%), *Eugenia aquea* (15.38%), *Cassia seamea* (14.39%), and *Anthocephalus cadamba* (10.49%).

**Table 4.** Vegetation composition of *S. cumini* habitat in customary Forest of Wonosadi Sub District, Gunungkidul District, Yogyakarta Province.

| No | Tree Species | Family | \(\sum\) Stands ha\(^{-1}\) | Kr (%) | Fr (%) | Dr (%) | INP (%) | H' |
|----|--------------|--------|----------------|--------|--------|--------|---------|----|
| 1  | *Acacia auriculiformis* | Fabaceae | 21 | 2.232 | 4.545 | 0.031 | 6.808 | 2.308 |
| 2  | *T. macrocarpa* | Apocynaceae | 25 | 2.679 | 4.545 | 0.128 | 7.352 |
| 3  | *Delonic regia Rafin.* | Fabaceae | 29 | 3.125 | 2.273 | 0.797 | 6.195 |
| 4  | *Anthocephalus cadamba* | Rubiaceae | 33 | 3.571 | 6.818 | 0.097 | 10.486 |
| 5  | *Syzygium cumini* | Myrtaceae | 288 | 30.804 | 13.636 | 79.111 | 123.551 |
| 6  | *Eugenia aquea* | Myrtaceae | 58 | 6.250 | 6.818 | 2.312 | 15.380 |
| 7  | *Anacardium occidentale* | Anacardiaceae | 67 | 7.143 | 4.545 | 3.476 | 15.164 |
| 8  | *Tectona grandis* | Verbenaceae | 8 | 0.893 | 4.545 | 0.077 | 5.515 |
| 9  | *Cassia seamea* | Fabaceae | 42 | 4.464 | 9.091 | 0.835 | 14.390 |
| 10 | *Eugenia Sp.* | Myrtaceae | 17 | 1.786 | 2.273 | 0.105 | 4.164 |
| 11 | *Mangifera odorata* | Anacardiaceae | 4 | 0.446 | 2.273 | 0.001 | 2.720 |
| 12 | *Vitek pubescens* | Verbenaceae | 4 | 0.446 | 2.273 | 0.001 | 2.720 |
| 13 | *Swietenia macrophylla* | Meliaceae | 21 | 2.232 | 4.545 | 0.034 | 6.811 |
| 14 | *Gnetum gnemon* | Gnetaceae | 4 | 0.446 | 2.273 | 0.001 | 2.720 |
| 15 | *Dillenia elliptica* | Dilleniaceae | 8 | 0.893 | 2.273 | 0.030 | 3.196 |
| 16 | *Caesalpinia sappam* | Caesalpinaceae | 8 | 0.893 | 2.273 | 0.011 | 3.177 |
| 17 | *Adenothera microserma* | Caesalpinaceae | 8 | 0.893 | 4.545 | 0.154 | 5.592 |
| 18 | *Paraserianthes falcataria* | Fabaceae | 13 | 1.339 | 4.545 | 0.026 | 5.910 |
| 19 | *Eryngium foetidum* | Umbelliferae | 21 | 2.232 | 4.545 | 0.368 | 7.145 |
| 20 | *Hibiscus tiliacus* | Malvaceae | 54 | 5.804 | 2.273 | 1.481 | 9.558 |
| 21 | *Mischocarpus sundaicus* | Sapindaceae | 200 | 21.429 | 9.091 | 10.928 | 41.448 |

| 933 | 100 | 100 | 100 | 300 |

Remarks: Kr (Relative Density), Fr (Relative Frucuency), Dr (Dominance Relatif) and INP (Important Value Indeks), H (Indeks Shanon Winner).

The private forest farmer does not plant the existence of *S. cumini* on private and customary forest. The study showed that *S. cumini* grew naturally in its habitat. The ratio of the number of *S. cumini* stands compared to other types of stands is higher in private forest habitats (50% of the total stands ha\(^{-1}\)) than in customary forest (30% of the total stands ha\(^{-1}\)). The diversity of tree species and total stands ha\(^{-1}\) in customary forests (21 species and 933 stands ha\(^{-1}\)) is higher than in private forests (10 species and 923 trees ha\(^{-1}\)). The customary forests were grown many types of stands that grew naturally without logging.
activities, while in private forests, logging activities were made. *S. cumini* grows in natural habitat along with other types of stands planted by the private forest farmer. *S. cumini* regeneration occurs naturally, namely natural regeneration. The study showed that *S. cumini* was relatively easy to adapt to marginal hilly land conditions with low fertility. The high level of organic matter in the two fields was probably due to no small amount of litter from the dense stands. This can be a potential source of nutrients/soil nutrients for the growth of *S. cumini*. The resistance level of *S. cumini* on marginal land is a possible type of critical land rehabilitation program. However, because the primary production of *S. cumini* is seeds/fruit, it is necessary to test the productivity of *S. cumini* on different land conditions.

4. Conclusions

The natural habitat of *S. cumini* was found in the hilly/mountainous area, with a thin layer of soil, lots of rocks, less fertile soil (N medium, P and K very low) at the altitude below 500 meters above sea level, rainfall above 1000 mm year⁻¹, the texture of clay, temperature 25-30 °C and mixed with other types of plants. The population of *S. cumini* in the private forest habitat was higher (417 stands ha⁻¹) than in the customary forest (288 stands ha⁻¹). The Important Value Index of *S. cumini* in the private forest in Bantul was higher (158%) than in the customary forest in Gunungkidul (123.5%). The study suggests that *S. cumini* could be a potential species for forest land and critical land rehabilitation activities. The existence of *S. cumini* could be developed as a source of medicinal raw material in the community forest.

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