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Characteristics of the moringa mother tree in the population of East Flores, East Nusa Tenggara

Abstract. The moringa plant (*Moringa oleifera* Lam.) is a member of the Moringaceae family that grows in Indonesia. The use of moringa plants in food production, animal feed, pharmaceutical manufacturing, and the cosmetics industry are just a few of their many advantages. The development of moringa plants in Indonesia has not been carried out because it is still constrained by the absence of a mother tree and a source of moringa seed gardens. This study aims to identify morphological characters and production potential in two populations of moringa plants. The research was conducted in August 2021 in East Flores District, East Nusa Tenggara Province. The research was conducted by determining the selected mother tree (SMT), observing morphological characters, and seed production. Exploration of selected parent trees was carried out using a survey method on two moringa plant populations in Tiwatobi and Harubala villages. Observations of plant morphological characters were carried out on quantitative and qualitative characters. The production potential is carried out by estimating the production of moringa seeds in each population. The results showed that there were 19 SMTs in the first population and 29 SMTs in the second population. 27 morphological characters have been observed, with the potential for seed production in each population of 314,554 seeds and 529,538 seeds per year.

Keywords: Moringa · Morphology · Mother tree · Population · Seed

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Introduction

Originally from southern Asia, the Moringa plant (*Moringa oleifera* Lam.) is a member of the Moringaceae family that can be found in northern India, Pakistan, Bangladesh, and Nepal (Roloff et al., 2009) This plant can grow in the lowlands to highlands in the tropics and subtropics. Furthermore, the moringa tree is known for its fast growth rate and ability to regenerate quickly after pruning or damage (Trigo et al., 2020). This plant can grow in a wide range of soil types and climatic conditions, including areas with low rainfall and poor soil fertility (Alia et al., 2022). Moringa plants can be found in Sumatra, Java, Sulawesi, and Nusa Tenggara in Indonesia (Roshetko et al., 2017).

Moringa plants are also known as "*the miracle tree*" because they have a high nutritional content, and are widely used as a functional food (Moyo et al., 2011; Muflihatin et al., 2021). Moringa leaves are highly nutritious and are known to contain a range of vitamins and minerals, making them a valuable food source in areas where malnutrition is prevalent (Dhawi et al., 2020; Ojo, 2019). The moringa leaf consists of high amounts of protein, essential amino acids, and antioxidants, further contributing to its value as a plant species (Abimbola & Olabisi, 2020). Moringa leaves have a content of vitamin C 4 times greater than oranges, vitamin A 10 times greater than carrots, calcium content 17 times more than milk, protein nine times more than yogurt and potassium 17 times greater than bananas, and iron content 25 times greater than spinach (Rockwood et al., 2013; Utami et al., 2022). In addition, various parts of the plant have been used for medical purposes due to their antimicrobial (Raju & Kei, 2022) and antioxidant properties (Bawadekji et al., 2019). Moringa leaves include quercetin and kaempferol, which have anti-diabetic and antioxidant properties (Siddhuraju & Becker, 2003; Gupta et al., 2012) frequently used parts are roots, bark, sap, leaves, pods, flowers, seeds, and seed oil. Moringa leaves' bioactive content can help people overcome heart disease, hypertension, insulin resistance, and cancers (Dhakad et al., 2019).

Moringa plants are found across Indonesia, particularly in the eastern islands of Sulawesi and Nusa Tenggara: Plant growth is influenced by heredity/genetic factors as well as the environment. So, to cultivate moringa plants with high output, seeds that are genetically beneficial in production and resistant to plant-disturbing organisms are required. The moringa mother tree's ability to adapt to different growing conditions, fast growth, and regeneration rate, deep taproot system for accessing water and nutrients, and its high nutritional and medicinal value make it an ideal plant species for a variety of purposes, including food security, health promotion, and environmental preservation (Alia et al., 2022). Unfortunately, no moringa plant variety has had high productivity (Suketi et al., 2016). Furthermore, characterization and inventory of moringa plant populations have not been regularly carried out in Indonesia to date, despite these activities being the initial step in plant breeding operations. The exploration of moringa plant characteristics and their potential uses is an important area of research, particularly in developing countries where food insecurity and malnutrition are pervasive issues (Dasat et al., 2020). As a result, efforts are required in Indonesia to explore, describe, and offer moringa plant seeds.

Materials and Methods

The research was conducted in August 2021 in East Flores Regency, East Nusa Tenggara Province (ENT). The material used is Moringa stands located in two different populations: Tiwatobi Village, Ile Mandiri District, and Harubala Village, Ile Boleng District, East Flores Regency. The tools used in this study were meters, digital cameras, *Global Positioning System* (GPS), calipers, ash-colored fabrics, labels, stationery, plastic bags, and digital scales.

Procedure. This research consists of several stages of activities, including:

Exploration and identification of the Moringa plant's mother tree. Due to its diverse and beneficial characteristics, the *Moringa oleifera* Lam. tree is a versatile and valuable plant species (El-Esawy et al., 2018). Moringa plant population exploration location was obtained based on information from the ENT Provincial Agriculture and Plantation Office and the East Flores Regency Agriculture and Plantation Office. The Moringa plant population used in this study has a minimum area of 0.25 Ha, is more than three years old, and is in the form of a bed according to Minister of Agriculture Decree Number 79/Kpts/KB.020/ 12/2020 concerning

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Guidelines for Moringa Plant Production, Certification, and Seed Supervision.

Purposive sampling is used to select the mother tree. The selection of the parent tree is based on observations of superior moringa plant phenotypes, the absence of plant-disturbing organisms, and high seed production compared to moringa plants within the population. The selected parent tree is then recorded and marked using paint/iron plates, and its coordinates are recorded.

Observation of morphological characters of Moringa plants. The morphological characters observed include qualitative and quantitative characters of moringa plants regarding moringa descriptors (Angadi & Jagadeesha, 2018). As qualitative character qualities, the shape of the leaves, the tip shape of the leaves, the base shape of the leaflets, the form of the stem, the color of the stem, the surface of the stem, the color of the fruit, and the color of the seeds were all observed. Tree height, canopy length, stem diameter, leaf length, leaf breadth, petiole leaf length, leaf child length, leaf child width, pod length and pod diameter, and seed quantity are among the quantitative parameters recorded. Moringa plants are also taxed every year to determine annual seed output.

Moringa seed production taxation. Seed taxation is carried out by observing the number of productive branches/trees (PB, branches with pods ready for harvest of more than 30%), the average number of pods/trees (NP), and the average number of seeds/pods (NS). The number of moringa/tree seeds was calculated by sampling physiologically mature pods on one of the productive branches. Finally, the potential of seeds/trees/year (PS) is calculated using the formula:

PS = PB x NP x NS x Number of harvests in 1 year

Results and Discussion

Moringa plant exploration. The Moringa plant is one of the people of ENT as a fence plant. Moringa plants are planted in small amounts in people's yards, therefore they are rarely found in large patches. Two populations of moringa plants were obtained in the form of costs based on the results of exploration in East Flores Regency, namely in Ile Mandiri District (08° 16'57.1", 123° 00'10.2") and Ile Boleng (08° 22'59", 123°17'11.3"). The moringa plant is referred to as marungge among the neighboring community. Moringa plants are used in ENT in the identical way as they are in other regions of Indonesia, namely as raw materials for vegetables and animal feed (Adli & Kuswanto, 2019).

Figure 1 The location of the Ile Boleng population's mother tree.

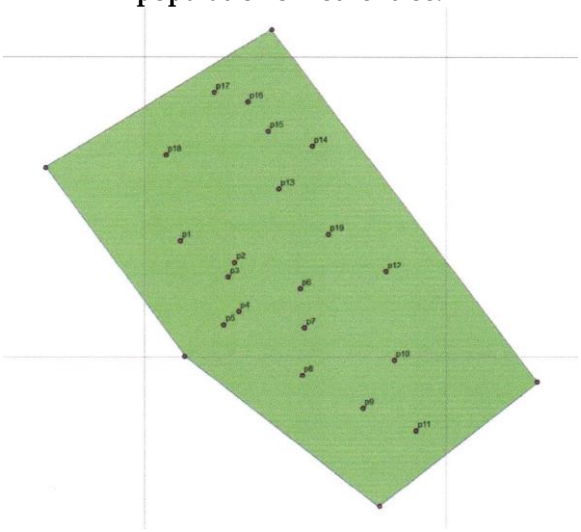

Figure 2. Location of selected mother trees in Ile Mandiri

The population of Ile Mandiri moringa plants is 9 m above sea level, planted in 2018 with an area of 0.5 Ha and 862 plants. The population of Ile Boleng moringa plants is at an altitude of 10 m above sea level, which was planted in 2013 with a land area of 0.5 Ha and a population of 627 plants. Both have a relatively flat topography (0-5%) and planting lengths that range from 1 m x 2 m to 3 m x 3 m to 4 m x 4 m. Following phenotypic selection, seed yield power of more than 3 kg/tree was achieved from as many as 19 trees in the Ile Mandiri

population and 29 trees in the Ile Boleng population as selected parent trees (SPT).

Characterization of diversity provides information on physical parameters such as leaf shape, harvest, plant height, and yield (Surahman et al., 2009). Moringa plant morphological characters observed include quantitative (Table 1) and qualitative (Table 2) characters. The population of Ile Mandiri moringa plants (7.59 m) has a greater average height when compared to the population of Ile Boleng plants (6.49 m). This height difference is thought to be because the planting distance in the Ile Mandiri population is tighter when compared to the Ile Boleng population. The leaf length of the Ile Boleng population (37 cm) is higher when compared to the Ile Mandiri population (35 cm) as well as the leaf width of the Ile Boleng population (25.10 cm) compared to the Ile Mandiri (25 cm). The same can be observed in the length and width of the leaflets and the length of the flower stalks. The length and width of the leaves of the Ile Boleng population (1.82 cm/1.42 cm) are higher than that of Ile Mandiri (1.80 cm/1.30 cm). Different results can be observed in stem diameter, petiole leaf length, pod length, pod circumference, number of seeds, and weight of 100 moringa seeds, where the Ile Mandiri population has a larger size when compared to the Ile Boleng population.

Table 1 The quantitative character of the Moringa plant population.

Parameter	Ile Mandiri	Ile Boleng
1. Height (meters)	7.59±1.44	6.49±0.38
2. Rod diameter (cm)	22.24±3.74	22.22±3.59
3. Leaf length (cm)	35.00±0.20	37.40±1.14
4. Leaf width (cm)	25.00±1.80	25.10±2.66
5. Leaf-child length (cm)	1.80±0.15	1.82±0.10
6. Leaf width (cm)	1.30±0.50	1.42±2.00
7. Panjang petiole (cm)	12.20±0.55	10.02±0.22
8. Flower stalk length (cm)	4.00±0.65	4.10±0.42
9. Pod length (cm)	40.72±1.77	40.33±0.70
10. Pod circum-ference (cm)	6.96±0.76	6.74±0.26
11. Number of seeds/pods	21.61±1.96	22.1±1.09
Weight: 100 seeds/tree (grams)	20.38±0.24	20.04±0.65

When viewed from the observed qualitative characters (Table 2), Ile Mandiri and Ile Boleng populations have the same qualitative characteristics in observing stems, leaves, pods, and seeds. The leaves in both groups have a pointed leaf base with rounded leaf tips and dark green on the leaf surface, with a whitish-green underside. Both groups had green petiole leaves with a purple color (Figure 3). Moringa plant flowers are normally white with yellowish-white pistils and stamens, and neither population has any anthocyanin color. Moringa plants have flowers that include both male and female organs, allowing them to self-pollinate (Zhang et al., 2018). The pods of the second moringa plant population are dark green while young and turn light brown with brown seed color when harvested. There was no difference between the two populations in terms of physical characteristics. Its shows that there is a possibility that the seed source between the two populations has the exact seed source origin.

Table 2 Characteristics of the Moringa plant population.

Character	Qualitative character	
	Ile Mandiri	Ile belong
Leaf		
1. The shape of the tips of the leaves	Rounded corners	Rounded corners
2. The shape of the base of the leaf child	Tapering	Tapering
3. Leaf color	Green	Green
4. Lower color of the leaves	Whitish green	Whitish green
5. Leaf petiole color	Green with a red tinge	Green with a red tinge
Flower		
6. Flowering phase	One month	One month
7. Petals	White	White
8. Stamens color	Yellow	Yellow
9. Petal color	Yellowish white	Yellowish white
Pods and seeds		
10. Light pod color	Dark green	Dark green
11. Old pod color	Light brown	Light brown
12. Seed color	Dark brown	Dark brown

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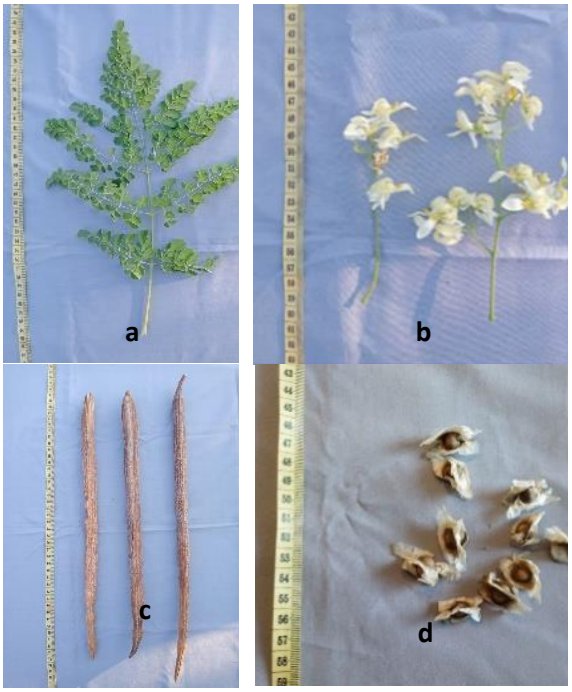

Figure 3. The character of leaves (a), flowers (b), fruits (c), and seed (d) of Moringa plants

Taxation of Moringa plant seed needs. Moringa has five harvest seasons, with two peak harvests in June and July. The flowering process of Moringa trees is heavily influenced by environmental conditions, particularly rainfall. Flowers fall off during the rainy season, decreasing pod production. The results of seed taxation (Table 3) show that the population of Ile Boleng (314,554 seeds/year) has a higher amount of seed production when compared to Ile Mandiri (529,538 seeds/year). The production of these two populations can be used as a seed source to propagate Moringa plants in ENT.

Table 3 Seed Taxation of Moringa plants per year

Population	Number of mother trees	Number of seeds/tree /year	Seed production (seeds/year)
Ile Mandiri	19	16,555	314,554
Ile Boleng	29	18,259	529,538

Conclusion

From the research that has been carried out, it can be concluded that:

1. The results of moringa plant exploration in East Flores Regency obtained two moringa plant populations, namely the Ile Mandiri population (19 SPT) and Ile Boleng (29 SPT).
2. As many as 27 morphological characters have been observed, including qualitative and quantitative characters, which shows no difference in morphological characters between the two populations.
3. Based on taxation, each population has a potential for seed production of 314,554 seeds (Ile Mandiri) and 529,538 seeds (Ile Boleng) every year.

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