Morphological characteristics of Mangosteen plants (*Garcinia mangostana* L.) in Langkat District, North Sumatera, Indonesia

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Abstract. Mangosteen is one of Indonesia's native fruit plants that has very large export potential, but at this time the age of mangosteen plants in smallholder plantations has reached more than ten years, so fulfilment of mangosteen export needs will be hindered. This study was aimed to identify the morphological characteristics of mangosteen plants and as a conservation material in several sub-districts (Wampu, Stabat and Tanjung Pura) in Langkat district of North Sumatra, Indonesia, with an accidental sampling survey based on the IPGRI (International Plant Genetic Resources Institute) mangosteen descriptor guide. The result showed that there were 51 characters closely related i.e. (growth, leaf, flower, fruit and seed descriptors) at E16 and E17 was 29.907, with 31 characters in common, and the furthest relationship was found between E1 and E3 with dissimilarity value 138.421 with 21 characters in common.

1. Introduction
Indonesia is a tropical country that produces a lot of fruits. Fruit production in Indonesia increases from year to year. According to data from the Ministry of Agriculture [1] fruit production in 2010 reached 17,254 million tons and is still increasing from year to year. Mangosteen (*Garcinia mangostana* L.) is one of Indonesia's horticultural commodities which is the focus of increasing production by the Ministry of Agriculture.

Garcinia is a plant genus of the tribe (familia) Clusiaceae [2]. In Indonesia, a lot of research has been carried out on this genus Garcinia, even its products have reached the market and are consumed as supplements and as vitamins under various brands. One of the species of Garcinia is mangosteen (*Garcinia mangostana* L.). This plant is a fruit tree originating from the Southeast Asia region which includes Indonesia, Malaysia, Thailand and Myanmar. In general, people only eat the fruit, then the mangosteen rind is removed. In fact, this fruit skin has traditionally been used in traditional medicine (diarrhea, dysentery, eczema and other skin diseases) [3].

The mangosteen plant is a type of plant with a very long juvenile period, where slow growth is caused by poor root systems, slow absorption of nutrients and water, low rates of photosynthesis and low rate of cell cutting in shoot meristems [4,5]. Mangosteen seeds are formed apomictically and develop from adventitious embryos asexually. The asexual regeneration of the mangosteen plant results in low genetic variability and genetically inherited traits from female parents.
At this time the age of mangosteen plantations in smallholder plantations has reached more than ten years, so that fulfilling the export needs of mangosteen will be hampered. Farmers are reluctant to plant mangosteen because it is difficult to get mangosteen seeds [3].

Diversity is the difference that results from the appearance of a plant population. Genetic diversity is one of the factors that greatly influence the success of plant breeding. The existence of genetic diversity in a population means that there are variations in genotype values between individuals in the population [6]. The sources of genetic diversity are obtained from introduction, crossing, mutation, or through the transgenic process. The result of crossing a common source of variation than create new sources of diversity. Diversity determines the effectiveness of selection. Selection will be effective when diversity is wide. Apart from diversity, heritability also determines the effectiveness of a selection. Heritability is a genetic parameter that measures the ability of a genotype in a plant population to inherit its characteristics. The higher the heritability value of a trait, the greater its genetic influence compared to the environment [7,8].

2. Materials and methods
This research was conducted in three mangosteen-producing sub districts, namely Wampu, Stabat and Tanjung Pura, Langkat district, from July 2018 to January 2019. The materials used consist of 27 mangosteen accessions.

The tools used in this study were a camera (Canon 600 D), a measuring device, questionnaire, GPS, and stationery. This research was conducted with an accidental sampling method or deliberately according to secondary data obtained through various sources of literature and related agencies, also adjusted to the conditions in the field. Data observation was carried out by collecting data on the sample based on the IPGRI (International Plant Genetic Resources Institute) mangosteen descriptor guide manual.

3. Results and discussion
The results of a survey indicated that mangosteen plant accessions were scattered in several villages. The following is the name of the village and the mangosteen plant accessions found in the area showed in table 1a and 1b.

| Sub-district | Village          | Plant Age | Altitude (m) | Accession Code | Coordinate point |
|-------------|-----------------|-----------|--------------|----------------|------------------|
| Tanjung Pura| Serapuh asli    | 35        | 4            | E1             | N 39°15.1952" E 98°40'108.80 |
|             |                 | 35        | 4            | E2             | N 39°15.2079" E 98°40'109.81 |
|             |                 | 27        | 4            | E3             | N 39°13.5321" E 98°40'287.50 |
| Pulau Banyak|                 | 15        | 4            | E4             | N 39°59.9895" E 98°43'487.30 |
|             |                 | 12        | 4            | E5             | N 39°59.9108" E 98°43'489.09 |
|             |                 | 7         | 4            | E6             | N 39°59.6174" E 98°43'467.46 |
| Baja Kuning |                 | 32        | 4            | E7             | N 39°35.5114" E 98°42'661.49 |
|             |                 | 32        | 4            | E8             | N 39°35.3291" E 98°42'644.33 |
|             |                 | 29        | 4            | E9             | N 39°36.4744" E 98°42'770.73 |
| Wampu       | Stabat Lama     | 32        | 28           | E10            | N 37°71.8629" E 98°43'030.80 |
|             |                 | 30        | 28           | E11            | N 37°72.1078" E 98°42'915.16 |
|             |                 | 30        | 28           | E12            | N 37°72.0780" E 98°42'920.16 |
| Stabat Lama  | Barat           | 14        | 28           | E13            | N 37°85.2164" E 98°43'937.62 |
|             |                 | 22        | 28           | E14            | N 37°85.4305" E 98°44'023.59 |
|             |                 | 24        | 28           | E15            | N 37°85.4546" E 98°44'014.03 |
|             | Jantera Stabat  | 31        | 28           | E16            | N 37°77.5800" E 98°43'986.74 |
|             |                 | 40        | 28           | E17            | N 37°76.9568" E 98°43'972.42 |
|             |                 | 40        | 28           | E18            | N 37°76.6373" E 98°43'981.34 |
### Table 1b. Research locations for mangosteen identification (Continue).

| Sub-district | Village       | Plant Age | Altitude (m) | Accession Code | Coordinate point                  |
|--------------|---------------|-----------|--------------|----------------|-----------------------------------|
| Stabat       | Paya Mabar    | 30        | 28           | E19            | N 37°62.3208" E 98°46'624.42     |
|              |               | 55        | 28           | E20            | N 37°62.1990" E 98°46'602.36     |
|              |               | 55        | 28           | E21            | N 37°61.9712" E 98°46'564.61     |
|              | Ara Condong   | 33        | 28           | E22            | N 37°82.8866" E 98°47'997.61     |
|              |               | 30        | 28           | E23            | N 37°76.6654" E 98°47'743.27     |
|              |               | 40        | 28           | E24            | N 37°75.4456" E 98°47'574.19     |
| Stabat Baru  |               | 30        | 28           | E25            | N 37°67.4428" E 98°46'296.62     |
|              |               | 37        | 28           | E26            | N 37°65.6356" E 98°46'105.31     |
|              |               | 29        | 28           | E27            | N 37°64.5777" E 98°46'031.99     |

Based on morphological characters on 27 accessions of mangosteen from three sub District in Langkat District, was obtained value of the kinship, shown in table 2.

### Table 2. Kinship relationship on 27 mangosteen accessions in three sub-districts in Langkat District, North Sumatra based on the dissimilarity matrix

| No. | Kinship Relations | Coefficient value |
|-----|-------------------|-------------------|
| 1   | E16               | E17               | 29.907           |
| 2   | E18               | E19               | 30.142           |
| 3   | E7                | E12               | 30.174           |
| 4   | E18               | E21               | 32.200           |
| 5   | E20               | E27               | 35.328           |
| 6   | E11               | E15               | 40.031           |
| 7   | E18               | E23               | 40.809           |
| 8   | E18               | E22               | 44.310           |
| 9   | E8                | E9                | 44.322           |
| 10  | E16               | E20               | 46.549           |
| 11  | E16               | E18               | 48.238           |
| 12  | E7                | E14               | 48.358           |
| 13  | E11               | E16               | 52.227           |
| 14  | E5                | E6                | 53.392           |
| 15  | E7                | E24               | 59.335           |
| 16  | E2                | E5                | 59.675           |
| 17  | E7                | E13               | 61.126           |
| 18  | E11               | E25               | 61.147           |
| 19  | E7                | E11               | 65.767           |
| 20  | E7                | E26               | 66.278           |
| 21  | E8                | E10               | 68.784           |
| 22  | E7                | E8                | 74.298           |
| 23  | E2                | E7                | 76.906           |
| 24  | E1                | E2                | 106.524          |
| 25  | E1                | E4                | 125.014          |
| 26  | E1                | E3                | 138.421          |
Based on table 2 (the dissimilarity matrix), with the smaller of the coefficient value between one variable and another, the kinship between the two variables is getting closer or the greater level of similarity and vice versa. So that it is known that the highest level of similarity is in $E_{16}$ and $E_{17}$ (29.907) with the same of 31 characters, and the farthest kinship is in $E_1$ and $E_3$ (138.421) with the same of 21 characters.

Based on table 2, the values of dissimilarity matrix values were obtained high, while mangosteen includes the plants that reproduce by seeds by apomixis, so that the mangosteen which derived from the seeds must have the same genotype as their parents. It is suspected due to the age of the plant which is old, the origin of plant seeds is unknown, and also environmental factors that influence it. According to [9] which states that in mangosteen, there are variations in leaf and fruit sizes that are thought to be caused by the environment.

In table 3, the grouping shows that the 27 mangosteen accessions that have been analysed are divided into 2, 3, and 4 groups where the groups formed are united by special characters and each group member is stated in a number according to the group.

| Genotype | 4 Groups | 3 Groups | 2 Groups |
|----------|----------|----------|----------|
| $E_1$    | 1        | 1        | 1        |
| $E_2$    | 2        | 1        | 1        |
| $E_3$    | 3        | 2        | 2        |
| $E_4$    | 4        | 3        | 1        |
| $E_5$    | 2        | 1        | 1        |
| $E_6$    | 2        | 1        | 1        |
| $E_7$    | 2        | 1        | 1        |
| $E_8$    | 2        | 1        | 1        |
| $E_9$    | 2        | 1        | 1        |
| $E_{10}$ | 2        | 1        | 1        |
| $E_{11}$ | 2        | 1        | 1        |
| $E_{12}$ | 2        | 1        | 1        |
| $E_{13}$ | 2        | 1        | 1        |
| $E_{14}$ | 2        | 1        | 1        |
| $E_{15}$ | 2        | 1        | 1        |
| $E_{16}$ | 2        | 1        | 1        |
| $E_{17}$ | 2        | 1        | 1        |
| $E_{18}$ | 2        | 1        | 1        |
| $E_{19}$ | 2        | 1        | 1        |
| $E_{20}$ | 2        | 1        | 1        |
| $E_{21}$ | 2        | 1        | 1        |
| $E_{22}$ | 2        | 1        | 1        |
| $E_{23}$ | 2        | 1        | 1        |
| $E_{24}$ | 2        | 1        | 1        |
| $E_{25}$ | 2        | 1        | 1        |
| $E_{26}$ | 2        | 1        | 1        |
| $E_{27}$ | 2        | 1        | 1        |

Based on table 3 and dendrogram formed (figure 1), it is known (based on the Euclidean distance scale 25) that the smaller of the Euclidean distance between some of the objects analysed, make it closer for the object's kinship and more similarities in the characters themselves [6,10].

The analysis of kinship based on the qualitative and quantitative characters on a scale of 25 formed into 4 groups, namely the first group (I) consisting of $E_1$, $E_2$, $E_4$, $E_5$, $E_6$, $E_7$, $E_8$, $E_9$, $E_{10}$, $E_{11}$, $E_{12}$, $E_{13}$,
E14, E15, E16, E17, E18, E19, E20, E21, E22, E23, E24, E25, E26, and E27, the second group (II) consists of E3, the third group (III) consists of E4, and the fourth group (IV) consisting of E1, E2, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16, E17, E18, E19, E20, E21, E22, E23, E24, E25, E26, and E27.

**Figure 1.** Dendogram based on the qualitative and quantitative characteristics of mangosteen in three sub-districts in Langkat district, North Sumatra.

Based on figure 2, it can be seen that the differences in the character of the mangosteen plant are the shape of the crown (pyramid, round, oblong, and elongated), oval leaf shape, leaf tip (tapered and blunt), leaf base (blunt and tapered), flower size (large, medium and small), fruit shape (round and round), fruit colour (creamy white and snow-white), and seed shape (ellipse, oval, long and irregular).

The second group which consists only of E3, this genotype has different characters compared to the other twenty-six genotypes. One of the special characteristics that E3 has the shape of the base of the leaf, which is rounded and the tip of the leaf is blunt. This character causes E3 to separate itself from other groups.

Character differences in E3 and E4 are stem surface, branch pattern, branch density, young leaf colour, leaf density, leaf base shape, leaf tip shape, flower size, fruit shape, lobe stigma colour, fruit size, pulp texture, the taste of the pulp, the colour of the pulp, the shape of the seeds and the colour of the coat. Meanwhile, there is a variety of E3 and E4 characters with 25 other samples found on the surface of the stem and leaf base at E3, and branch patterns, young leaf colour and fruit size at E4.

The differences in the characters found in E1 and E4 are the shape of the crown, the pattern of the branches, the density of the branches, the colour of the young leaves, the density of the leaves, the duration of flowering, the size of the flowers, the shape of the fruit, the spots on the lobe stigma, the size of the fruit and the texture of the pulp. Comparison in E1 and E4 with 25 other samples, there is a diversity of characters, namely leaf density, leaf top surface, and taste of pulp at E1 and branch patterns, colour of young leaves, size of flowers, size of fruit and taste of pulp at E4.

The character diversity of E1 compared to E2, E3, E4, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16, E17, E18, E19, E20, E21, E22, E23, E24, E25, E26, and E27 others are leaf density, leaf top surface and pulp taste.
**Figure 2.** The differences in morphological characteristics of mangosteen trees, leaves, flowers, fruits and seeds in Langkat District, North Sumatra.

4. Conclusions
The closest kinship was found in $E_{16}$ and $E_{17}$ from Wampu sub-district with the same dissimilarity value of 29.907 with 31 characters, while the farthest obtained was in $E_1$ and $E_3$ from Tanjung Pura sub-district with a dissimilarity value of 138.421 with the same 21 characters. The $E_3$ accession is separate from the other 26 accessions, this is because the $E_3$ accession has a special character, namely the shape of the leaf base is rounded and also the shape of the leaf tip is blunt.

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