Flower morphology diversity of asam gelugur (Garcinia atroviridis griff, ex t. anders) accessions in several districts of North Sumatera, Indonesian

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Abstract. The research aims to study of flower morphology of G.atroviridis plants in several Districts of North Sumatera. This study was conducted in Asahan, Batubara and Serdang Berdagai districts in February to April 2017, exploration using survey method with IPGRI descriptors guide, and accidental sampling. The research results showed that in three Districts of Sumatera Utara, there are 26 accessions of Asam Gelugur characterized based on morphology of flowers. Based on clustering analysis using the NTSYS-pc Program, all flower morphology data resulted in dendogram with similar coeffisien range from 0.34 to 0.75 into four groups. The first group (I) consists of 16 accessions i.e. Asahan, Batubara and Serdang Bedagai districts. The second group (II) in Asahan, Batubara and Serdang Bedagai districts there are 7 accessions. The third group (III) consists of two accessions, i.e. Asahan and Batubara Districts. The fourth group (IV) consists of one accession in Serdang Bedagai District is the only outgroup access.

1. Introduction
Asam Gelugur is a plant that spread in tropical area of Asia. The plant is divided into two widely known species, namely Garcinia cambogia commonly found in southern India, while other species, namely Garcinia atroviridis (Asam Gelugur) are commonly found in the Malay Peninsula region [1]. Asam Gelugur (Garcinia atroviridis Griff ex T. Anders) is a tropical and subtropical annual tree originating from South Asia and Southeast Asia and is widely grown Sumatera island [2]. The spreading area of G.atroviridis in Indonesia is from Aceh to South Sumatra. Asam Gelugur so far is categorized into two kinds of fruit by Sumatera Utara citizen, namely G.atroviridis rock type and water type. Rock type is smaller, while water type larger and contain more water.

One commodity that has the potential to become an export commodity in North Sumatera is G.atroviridis. Actually this plant has already existed in this area for a long time, but the utilization is only for simple purposes. G.atroviridis in North Sumatera used by the community as a food ingredient. Generally this fruit is cut into thin, then dried and after that it's used as a mixture for food. G.atroviridis also can be processed into sweets and tasty jams, can be prepared as a substitute for Asam Jawa (Tamarinus Indica), also can be used for seasoning, fish preservatives, syrups and acidic ingredients for latex processing[3].

Based on [4], G.atroviridis fruit contains strong antioxidants because of the content of hydroxysitic acid compounds. G.atroviridis the bioactivity of methanol-DMSO extracts from this plant which gave the result that the extract was antibacterial (root), antifungal (fruit and leaves), antioxidants (roots, fruit and stems), and antitumor (leaves, fruits and root).
Crop characteristics of each cultivation area has not been identified and the utilization is still very modest due to the lack of information in terms of characteristics [5]. In particular, knowledge of its sexual and breeding systems, important for designing suitable breeding strategies in order to increase fruit production, is limited [6].

Based on [7] literature, stated that flowers on Asam Gelugur plant is hermaphrodite or mono-sexual, so it has the ability to breed with flowers derived from the same tree and called plant with two houses (Diecious). The flowers have four dark red petals and on the edge of each petal are yellow. The sexual system of *Garcinia atroviridis* is evaluated regarding of basic structural specialization and reproductive character in natural conditions. This species is included as gynodioecious with female flowers (the tree produces female flowers/stigma), but also hermaphrodite flowers (trees that produce perfect flower) [8].

The hermaphrodite flowers have more flowers than the female flowers, but fall gradually before they bear fruit. In contrast, female flowers have relatively larger ovules on each flower, resulting in larger fruits and more seeds in fruit than the hermaphrodite flowers. In diecious plants, the sex identification can see based on the flower morphology, so needed the information for characteristics the flower morphology and the plant can be distinguished before fruiting, whether hermaphrodite or female.

2. Materials And Methods

The materials used in this research are 26 accessions of *G. atroviridis* in three districts in Sumatera Utara i.e. Asahan include the Sub-district of Air Joman, Silo Laut, Setia Janji, Pulau Bandring, Batubara include Sub-district of air Putih. Lima Puluh, Talawi, and Serdang Bedagai district include Sipispis, Pantai Cermin Kiri, Perbaungan, Sei Rempah and Tebing Tinggi Sub-districts. The tools used in this research are camera (Nikon D5300), meter, term slide, scales, white cloth, label, GPS, questionnaires and stationery. Determining the location of research based on information from the community for the area of *G. atroviridis* plants.

Parameter observed of flower morphology include position of flower, flower size, petal colour and sepal colour.

To know phenotypic diversity and kinship relationship between accession of gelugur acid, morphological data of each accession of gelugur acid was processed using cluster analysis and dendrogram using UPGMA method (Unweighted Pair Group Method Arithmetic) method using NTSYS (Numerical Taxonomy and Multivariate System) version 2.02 [9].

3. Results And Discussion

The survey results in three Sumatera Utara's districts; Asahan (P1-P9), Batubara (P10-P20) and Serdang Bedagai (P21-P26) showed that *G. atroviridis* accession was spread in several villages. Other data found in the survey is plant’s age from interview of farmer, altitude and coordinat using gps.

3.1. Asam Gelugur Flower Morphological Characteristics

Based on morphological identification of Asam Gelugur in three districts in North Sumatera that has been done, from 26 Asam Gelugur accession found in various villages by the three districts. There are some dominant morphological characters that can distinguish the 26 accessions of Asam Gelugur. One of which is the morphology of flowers.

In flower size parameter there are three variations that is small, medium flower size found in Asahan districts, and big flower in Asahan district, Batubara and Serdang Bedagai districts. On the parameter of interest position there is only one variation that is at the end contained in 26 accessions of *G. atroviridis* identified in Asahan, Batubara and Serdang Bedagai districts. In the color parameter of petals there are only five variations on 26 accessions of gelugur acid which is identified as green yellow in Asahan district two accessions and Serdang Bedagai district there is one accession, green petal color is found in Batubara district there is one accession and Serdang Bedagai there is one accession, red. There are six accessions, yellow with red fringes contained in three districts of Asahan, Batubara, Serdang Bedagai districts, yellow green with red margin in Asahan, Batubara and Serdang
Bedagai districts. In the color parameter of the petal flowers there are three variations on 26 accessions of G.atroviridis that is identified is green yellow contained in Batubara District with one accession, yellow with red margin is in District of Asahan with two accession, district of Batubara with three accession and Serdang bedagai there are two accessions, Red of petal colour in Asahan districts there are eight accession, five district of Batubara accession and in district of Batubara there are four accession.

**Figure 1.** Difference of female and hermaphrodite flowers (A) from typical female flower is solitory (B) Female flowers produces less pollen (C) From typical hermaphrodite flowers is cluster (D) Hermaphrodite flowers produce less pollen has a relatively long filament and produces abundant and fertile pollen

**Figure 2.** the position of female flowers become fruit (A) pistillate flower and buds at terminal stalk, (B) pistillate flower and immature fruits, (C) fruits of *G.atroviridis*
There were significant morphological and anatomical differences between female flowers and hermaphrodite flowers (figure 1). The hermaphrodite flower has a relatively long filament and produces abundant and fertile pollen, whereas females produce less pollen. They also differ significantly in reproductive traits. The hermaphrodite flowers have more flowers than the female flowers, but fall gradually before they bear fruit. In contrast, female trees have relatively larger ovules on each flower, resulting in larger fruits and more seeds per fruit than the hermaphrodite tree [10]. Following the position of female flowers become fruit (figure 2).

The Characterization of observed flower morphology include flower position of female and hermaphrodite, the size of flowers (small medium large), sepal and petal colours of flowers. The diversity of flower morphological character in three districts in Sumatera Utara; Asahan, Serdang Bedagai and Batubara are: (figure 3 as follows).

**Figure 3.** A. position of flowers terminal of the stalk, B. Flowers size are (a) small (b) medium (c) large, C. Petal colours are (a) yellow green (b) yellow with red margin (c) red (d) yellow with red margin, D. Sepal colours are (a) green with red margin (b) yellow with red margin (c) red
3.2. Phenotypic Diversity between Individuals

The UPGMA analysis of 26 Asam Gelugur accessions based on 4 characters of flower morphology is presented in Figure 4. Based on the similarity of characteristics that exist among several accessions of Asam Gelugur in some North Sumatera districts can be seen in the picture below:

![Dendogram from UPGMA analysis of 26 Asam Gelugur accessions in Asahan, Batubara and Serdang Bedagai districts.](image)

From cluster analysis of flower morphology resulted in dendogram obtain two main group, the first group (I) consist of 25 accessions in Asahan, Batubara and Serdang Bedagai districts with coefficient 75%, which is generally the petal colour is red, sepal colour is yellow with red margin. The second group (II) in Batubara district is the only outgroup access because the petal colour in yellow green to distinguish from other accessions with coefficient 32% (figure 5). the first group (I) is divided into two subgroups where the first group (IA) consists of 24 accessions with coefficient 75%, which is generally the petal colour is red, sepal colour is yellow with red margin. The second group (IB) in Serdang Bedagai district is the only outgroup access because medium size flower as well petal and sepal colours is yellow with red margin with coefficient 35% (Figure 5).

![P23 and P17](image)

Figure 5. Two accessions out group are P23 and P17
Based on the phylogenetic relation analysis of Asam Gelugur in several districts in North Sumatera, i.e., Asahan, Batubara and Serdang Bedagai districts 26 accessions were obtained that each Asam Gelugur accession in three Sumatera Utara districts have relatively close relation that is equal to 56%.

4. Conclusion
Based on cluster analysis on flower morphological characters of 26 accessions in three Districts of North Sumatera using the NTSYS-pc Program, all flower morphology data resulted in dendogram with similar coeffisien range from 0.32 to 0.75. The characterization of flower morphology 26 accessions from position of flowers terminal of the stalk, various such as petal colour are yellow green, red and yellow with red margin, various such as sepal colour are green with red margin, red and yellow with red margin

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