

# Phylogenetic relationship of asam gelugur (*Garcinia atroviridis* Griff. ex T. Anders) based on morphological characters in Langkat and Serdang Berdagai, Sumatera Utara

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**Abstract.** *Garcinia atroviridis* plant is a commodity that has the potential to become an export commodity in Sumatera Utara. Characterization is an activity in germplasm to determine the morphological properties that can be utilized in differentiating between accessions and assessing the magnitude of genetic diversity. The magnitude of genetic diversity based on morphological properties can support breeding programs. The research was conducted in several areas of *G. atroviridis* plant, i.e. Gebang, Bahorok, Padang Tualang, Pegajahan, Sei Rampah, Pantai Cermin, and Perbaungan sub-districts in September 2016 with direct observation method. The aim of this research is to explore and characterization between *G. atroviridis* plant in Langkat and Serdang Berdagai. Parameters morphology characters were observed based on IPGRI, and observation data were analyzed by using SPSS version 21 to obtain the dendrogram. The dendrogram results showed that there are four groups of kinship relationships on the scale of the spacing (euclidean distance scale) 17. The lowest unequal value (closest kinship) in accessions G3(Bahorok) and G7(Sei Rampah) is 16.328 while the highest value of inequality (farthest kinship) in G5( Padang Tualang) and G6 (Pegajahan) is equal to 54.187. It needs the conservation of *G. atroviridis* although must be done next observation.

## 1. Introduction

Germplasm is one of the most important natural resources and is the basic capital needed to develop the agricultural industry. Germplasm is a necessary genetic resource, one of which is to develop new varieties or cultivars. The high diversity of germplasm we have, open the opportunity to search for, utilize, discover, and optimize uncharted genetic potential [1]. One of Indonesia's biological riches is *Asam Gelugur* (*Garcinia atroviridis* Griff. ex T. Anders.). *Asam Gelugur* is a fruit belonging to the *Guttiferae* family and the *Garcinia* genus. This fruit grows a lot in the area of Sumatera Utara.

*Garcinia* clan plants spread in Asia tropical region. The well-known species, *Garcinia cambogia*, are commonly found in southern India, while other species, namely *Garcinia atroviridis* (*Asam Gelugur*) commonly found in the Malay Peninsula region [2]. The *Asam Gelugur* or Gelugor is widely used as a flavoring dish by the Malay community. This plant is still a family with Mangosteen and *Asam Kandis* that spread in Southeast Asia. This plant belongs to the *Guttiferales* ordo and *Guttiferae* family whose height can reach 20 m [3].

In Indonesia *Garcinia* is a widely distributed plant and an important part of forest composition. In the forest, it is often encountered as a plant in the second storey based on the height of the tree. Based on existing data in Herbarium Bogoriense in Indonesia there are about 100 types of *Garcinia*. In the



world, the number is estimated to reach 400 species. This means about a quarter of the world's *Garcinia* species are in the Indonesian region [4].

*G. atroviridis* is widely used as a flavoring cuisine by the Malay community, But also proved beneficial for lowering cholesterol. It is also an antioxidant and can reduce body weight and cholesterol. Mackeen [5] investigated the bioactivity of water ethanol extracts from this plant which gave the result that the extract had antibacterial, antifungal, antioxidant, antitumor, and antimalarial activity.

Commercially *G. atroviridis* has been exploited by the international industry as a health food to burn highly potent fats (slimming), lowering cholesterol, hypertension, rheumatism, processed in capsules and syrups. *G. atroviridis* fruit now has a high economic value and began commercialized with a fairly high selling price of 60000 IDR / kilogram in dry processing mode. This product has been marketed to Medan, Teluk Kuantan and overwhelmed to meet demand due to shortage of raw materials [6].

New varieties may arise due to environmental factors and genetic variation, such as due to cross-pollination. The differences and similarities of morphological emergence outside the species of a plant can be used to know the proximity of kinship relationships [7].

Information on diversity is essential in plant breeding programs, because with the availability of such information, it is easier in determining the position or kinship between varieties that can be used as the basis of plant selection. Renwain et al [8] stated that the success of plant breeding programs to improve the character of a plant is largely determined by the availability of genetic resources.

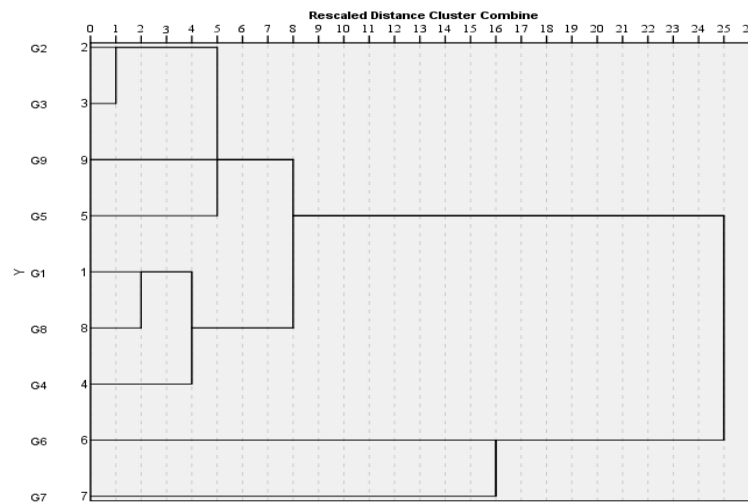
The collection of diversity information is carried out through enrichment activities such as exploration. With this activity the opportunity for the emergence of the desired genetic potential may be available [9]. Therefore, it is necessary to identify a plant. Characterization of collections (accessions) performed, aimed at obtaining data on the nature or character of agronomic morphology (basic morphological description) so as to distinguish the phenotype of each accession quickly and easily, by estimating the scale of genetic diversity it possesses [10].

## 2. Methode

The research was conducted by exploring Langkat and Serdang Bedagai regencies with direct observation method in September 2016. The materials used in this research are 9 accessions of asam gelugur in seven sub-districts in Deli Serdang regency, i.e. Gebang (G1, G2), Bahorok (G3, G4), Padang Tualang (G5), Pegajahan (G6), Sei Rampah (G7), Pantai Cermin (G8), and Perbaungan (G9). Observations were performed on 34 morphological characters including stems, leaves, flowers, fruits and seeds. Morphological characters on stems, leaves, flowers, fruits and seeds were observed based on IPGRI (2003). Documentation is done using a digital camera (Nikon D5300). The color is measured according to the Royal Horticultural Society (5th Edition) standard color chart. Data is processed and analyzed using hierarchical cluster analysis method with Euclidean distance concept. Parameters observed include plant height, bar length, stem circle, stem surface appearance, crown shape, young leaf color, old leaf color, leaf size, leaf shape, leaf base shape, leaf tip shape, leaf margin, leaf bone, flower size, flower position, flower petal color, flower crown color, fruit shape, number of fruit segment, fruit diameter, fruit weight, fruit size, fruit skin thickness, ripe fruit color, seed length, seed width, number of seeds per fruit, seed shape and seed color.

## 3. Result and Discussions

The analysis results from the part of *Garcinia atroviridis* plant covering the tree height, trunk height, trunk circumference, trunk surface and crown shape are made in a dendrogram (Figure 1). From the analysis of the trunk, nine accessions of *G. atroviridis* in Langkat and Serdang Bedagai district can be divided into three groups at euclidean distance scale 16. The first group is G1, G2, G3, G4, G5, G8 and G9. The second group is G6. The third group is G7.



**Figure 1.** Results of trunk analysis

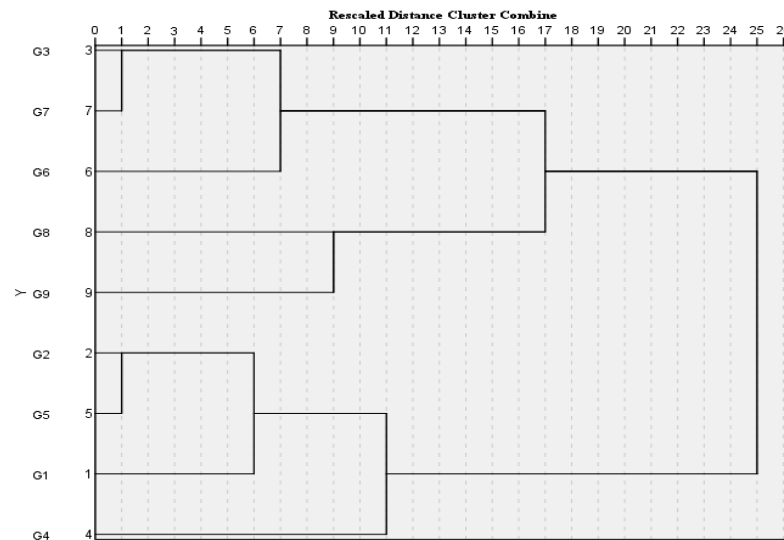
**Table 1.** Trunk characteristics of *Garcinia atroviridis*

Accession Code	Characteristic				
	Tree Height	Trunk Height	Trunk Circumference	Trunk Surface	Crown Shape
G1	11.5	2.7	105	Rough	Pyramid
G2	11.5	2.4	115	Rough	Spherical long
G3	12.5	3.5	110	Rough	Spherical long
G4	7.5	2.1	90	Rough	Pyramid
G5	9.5	2.1	85	Rough	Spherical long
G6	27.5	12.0	330	Very Rough	Spherical long
G7	21.5	3.7	310	Very Rough	Pyramid
G8	12.5	2.5	97	Rough	Pyramid
G9	15.5	6.3	94	Rough	Spherical long

Based on tree height, 9 observed accessions were grouped into 3 groups, i.e. short (5-10 m), moderate (11-16 m) and high (> 16 m). G4 and G5 include the short type. G1, G2, G3, G8 and G9 are of moderate type, while the high types are G6 and G7. (Table 1)

From 9 accessions of *Garcinia atroviridis* observed, G4 and G5 is the accession that has the shortest trunk height with 2.1 meters while the longest trunk height is G6. In the trunk circumference parameter, it is known that the smallest trunk is in G5, which is 85 cm, while the largest trunk is in G6 of 330 cm.

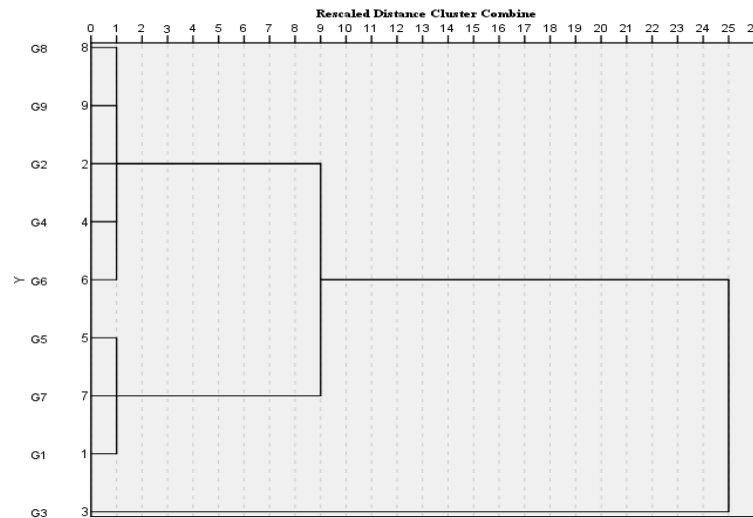
The analysis result from the leaf of *Garcinia atroviridis* included young leaf color, mature leaf color, leaf size, leaf shape, leaf base shape, leaf apex shape, leaf blade margin and leaf venation are made in a dendrogram (Figure 2). From the results of leaf analysis, nine accessions of *Garcinia atroviridis* in Langkat and Serdang Berdagai district can be divided into three groups at euclidean distance scale 17. The first group is G3, G6 and G7. The second group is G8 and G9 while the third group consists of G1, G2, G4 and G5.

**Figure 2.** Result of leaf analysis**Table 2.** Leaf characteristics of *Garcinia atroviridis*

Accession Code	Characteristic								
	Young Leaf Color	Mature Leaf Color	Leaf Length (cm)	Leaf Width (cm)	Leaf Shape	Leaf Base	Leaf apex	Leaf margin	Leaf venation
G1	Light green	Dark green	17.5	5.6	Lanceolatus	Oblique	Acute	Entire	Prominent
G2	Light green	Dark green	19.5	6.2	Oblong	Oblique	Acute	Entire	Prominent
G3	Light green	Dark green	23.1	8.4	Oblong	Rounded	Obtuse	Entire	Prominent
G4	Light green	Dark green	22.5	7.2	Oblong	Oblique	Acute	Entire	Prominent
G5	Light green	Dark green	20.2	6.8	Oblong	Oblique	Acute	Entire	Prominent
G6	Light green	Dark green	20.5	8.2	Oblong	Rounded	Obtuse	Entire	Prominent
G7	Light green	Dark green	21.3	8.5	Oblong	Rounded	Obtuse	Entire	Prominent
G8	Light green	Dark green	21.6	8.4	Elliptic	Oblique	Obtuse	Entire	Prominent
G9	Light green	Dark green	19.2	7.1	Elliptic	Oblique	Obtuse	Entire	Prominent

Based on the data obtained, it is known that from the nine accessions observed; the longest leaf length parameter found in accession G3 with 23.1 cm and the shortest leaf length is at accession G9. As for the largest leaf width parameter found in accession G7 with 8.5 cm and the smallest leaf width is in accession G1 with 5.6 cm. (Tabel 2)

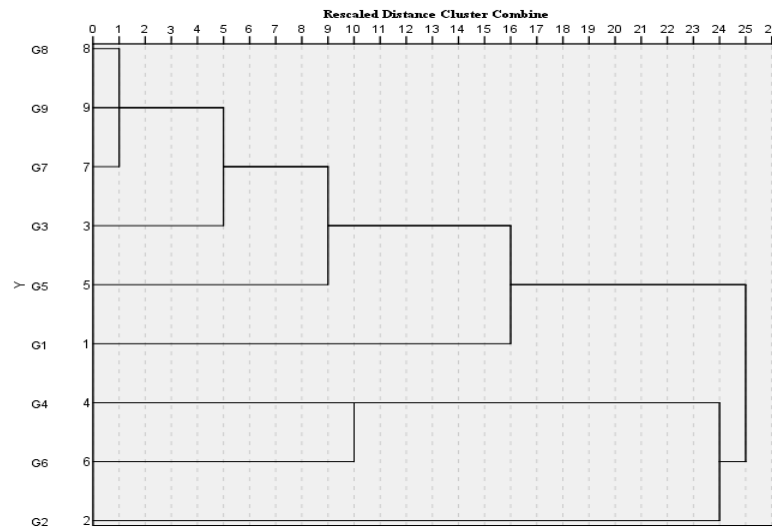
The cluster analysis result for the flower size was made into dendrogram (Figure 3). The size of the flowers can be divided into three groups at eucliden distance scale 9. The first (large) groups are G2, G4, G6, G8 and G9. The second (medium) group is G1, G5 and G7. The third (small) group is G3.

**Figure 3.** Flower size**Table 3.** Flower characteristics of *Garcinia atroviridis*

Accession Code	Characteristic			
	Flower Size	Position of Flower	Sepal Color	Petal Color
G1	Medium	Terminal	Yellow with red margin	Red
G2	Large	Terminal	Yellow with red margin	Red
G3	Small	Terminal	Yellow with red margin	Red
G4	Large	Terminal	Yellow with red margin	Red
G5	Medium	Terminal	Yellow with red margin	Red
G6	Large	Terminal	Yellow with red margin	Red
G7	Medium	Terminal	Yellow with red margin	Red
G8	Large	Terminal	Yellow with red margin	Red
G9	Large	Terminal	Yellow with red margin	Red

Primary parts or construction of flowers in this accession are very similar. They are composed of four sepal and four petals. Petal and color of this accession red and yellow with red margin. (Tabel 3) The analysis results of fruit from nine accessions of *G. atroviridis* in Langkat and Serdang Berdagai districts can be grouped into three groups at eucliden distance scale 24 (Figure 4). The first group is G1, G3, G5, G7, G8 and G9. The second group is G4 and G6. The third group consists of only one accession that is G2.

Observation on the morphological character of number of fruit segments on the *G. atroviridis* is discovered that the highest number of fruit segments are in G6 accession which is 15 segments, meanwhile the smallest number of fruit segments is in the G2 with 9 segments. For the parameter of fruit diameter the largest one found in G4 accession that is equal to 102.20 mm while the smallest is in G5 accession that is 75.30 mm. In the parameter of fruit weight the largest one is found in G4 accession with 420 g in accordance with the wide diameter, while the smallest fruit weight is in G7 accession with 200 g.(Tabel 4).

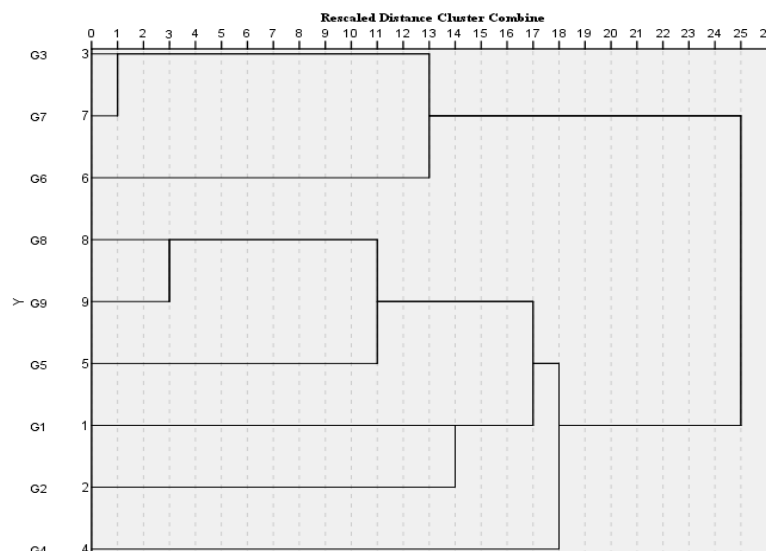
**Figure 4.** Result of fruits analysis**Table 4.** Fruit characteristics of *Garcinia atroviridis*

Accession Code	Characteristic						
	Shape	Number of Fruit Segmen	Fruit Diameter (mm)	Fruit Weight (g)	Fruit Size	Fruit Skin Thickness	Mature Fruit Color
G1	Flattened	16	93.30	370	Big (>140g/fruit)	Thin	Bright yellow
G2	Round	9	83.25	320	Big (>140g/fruit)	Thin	Bright yellow
G3	Flattened	14	85.20	280	Big (>140g/fruit)	Thin	Bright yellow
G4	Round	12	102.20	420	Big (>140g/fruit)	Thin	Bright yellow
G5	Ovoid	13	75.30	210	Big (>140g/fruit)	Thin	Bright yellow
G6	Round	15	90.25	350	Big (>140g/fruit)	Thin	Bright yellow
G7	Flattened	14	86.30	200	Big (>140g/fruit)	Thin	Bright yellow
G8	Flattened	14	90.15	280	Big (>140g/fruit)	Thin	Bright yellow
G9	Flattened	11	87.25	260	Big (>140g/fruit)	Thin	Bright yellow

**Table 5.** Seed characteristics of *Garcinia atroviridis*

Accession Code	Characteristic				
	Seed Length	Seed Width	Number of Mature Seed / Fruit	Seed Form	Seed Color
G1	10.5	8.4	5	Reniform	Light brown
G2	11.0	7.5	1	Reniform	Light brown
G3	-	-	-	-	-
G4	-	-	-	-	-
G5	-	-	-	-	-
G6	-	-	-	-	-
G7	-	-	-	-	-
G8	-	-	-	-	-
G9	11.5	8.5	5	Reniform	Light brown

The seed analysis results of *Garcinia atroviridis* (Table 5) showed that from nine accessions identified only three accessions that found have seeds. This is because the fruits of *G. atroviridis* generally only have a few seeds and some do not have seeds.



**Figure 5.** The result of all morphological characters analysis

### 3.1. Phylogenetic Relationship of *Garcinia atroviridis* in Langkat and Serdang Bedagai

The kinship relation analysis is done using hierarchical cluster analysis technique, which is grouping the objects based on the similarity of characteristics among the objects. Those objects are classified into one or more clusters (groups) so that objects that are in one cluster will have a resemblance to one another [11]. The cluster analysis technique was applied to the observation data of 27 morphological characters from 9 accessions of *Garcinia atroviridis*, so that the relationship of nine accessions of the *Garcinia atroviridis* was obtained.

Based on the dendrogram formed (Figure 5), it is obtained two groups, three groups, and four groups of phylogenetic relationship on the scale of the spacing (euclidean distance scale) 17, 18, and 25. The smaller the euclidean distance between the objects analyzed, the closer the phylogenetic relationship of the object and the more similar character it has [11]. An analysis of phylogenetic relationship based on morphological characters on a distance scale of 25 indicates the presence of two plant kinship groups (Figure 5). The first group consists of three accessions of *Garcinia atroviridis*, namely G3, G6 and G7. The second group consists of 6 accessions, namely G1, G2, G4, G5, G8 and G9.

The analysis of phylogenetic relationship based on morphological characters of euclidean distance scale 18 showed there are three groups (Figure 5). The first group consists of three accessions of *Garcinia atroviridis*, namely G3, G6 and G7. The second group consists of 5 accessions, namely G1, G2, G5, G8 and G9. The third group consists of only one accession, G4.

The analysis of phylogenetic relationship based on morphological characters of euclidean distance scale 17 showed there are four groups (Figure 5). The first group consists of 3 accessions of *Garcinia atroviridis* that is G3, G6 and G7. The second group consists of 3 accessions: G5, G8 and G9. The third group consists of 2 accessions, namely G1 and G2. The fourth group consisted of only one accession, G4.

The lowest dissimilarity or closest relationship were obtained in G3 from Langkat and G7 from Serdang Bedagai district with 16.328 by some character difference from 27 characters observed. This is in accordance with the literature Suskendriyati et al [7] which states that the emergence of some differences and similarities within the species outer morphology of a plant can be used to determine the proximity of relationship.

The highest dissimilarity or the farthest relationship is obtained in G5 from Langkat and G6 from Serdang Bedagai regencies which is 54.186 with some character difference from 27 characters observed that is form of canopy, leaf shape, leaf base shape, leaf tip shape, size of flowers and fruit



shape. This generally indicates that the morphological similarity level of the 9 identified accessions of *Garcinia atroviridis* is relatively close. This is in accordance with the literature of Cahyarini et al (2004) which states that the distance of similarity is said to be far if less than 0.6 or 60%. So from the grouping it can be said that the nine accessions observed have very little relationship.

#### 4. Conclusion

Based on cluster analysis on morphological characters of nine accessions of *Garcinia atroviridis* in Langkat and Serdang Bedagai regencies, there are four groups of phylogenetic relationship on the euclidean distance scale 17. The closest relationship is G3 and G7 with a coefecient dissimilarity 16.328 and farthest relationship is G5 and G6 with a coefecient dissimilarity 54.187.

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