



Relationship of Local Ambon Bananas in Rejang Lebong District of Bengkulu Based on Morphological Characteristics

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ABSTRACT

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Morphological characterization is initial information in finding diversity and determining desired superior characters. The purpose of the research is to conduct morphological characterization and determine the relationship of local Ambon banana in Rejang Lebong District. This study was conducted during September to October 2019, utilizing a field survey method with purposive sampling to investigate the morphological characterization and determine the relationship of local Ambon bananas in Rejang Lebong District. The kinship relationship of each type of local banana *Ambon Curup* consists of 3 related groups, where 1st group belongs to *Ambon Kuning*, *Ambon Curup*, *Ambon Hijau* and *Ambon Lumut*, the 2nd group is *Ambon Pendek*, and the 3rd group consisted of *Ambon Putih* and *Ambon Dingin*. The closest kinship is between *Ambon Kuning* and *Curup*, with a similarity level of 93,67 %, while the *Ambon Curup* owns the farthest kinship level with *Ambon Pendek*, which is 48,37%. The high genetic diversity is caused by the frequent occurrence of random inter-species mating.

INTRODUCTION

Bengkulu's local Ambon bananas possess valuable germplasm with significant economic potential, making it crucial to preserve and develop this resource. This event is demonstrated by the registration of several local Ambon banana cultivars at the Plant Variety Protection Center (Pusat Perlindungan Varietas Tanaman) number 435/PV/2017. These cultivars include Hj. Kuning, Hijau, and Rejang varieties. Prahardini *et al.* (2016) have

highlighted that genetic improvement in plants can be observed through their morphological features, such as stems, leaves, flowers, and fruits. However, to establish real kinship between different banana varieties, high precision is necessary to avoid misidentification. However, morphological characteristics alone may not be sufficient to evaluate the kinship of a plant, as environmental factors can significantly impact the expression of these characteristics. As noted by (Suparman, 2018) errors in identifying and assessing the kinship of plants

are commonly encountered.

The impact of environmental factors on plant diversity was also highlighted by Sultan, Kadekoh, and Sahiri (2016), who noted that environmental variations could lead to a wide range of plant species. The relationship between plants can be determined through morphological characterization in the field using the Minitab 16 software program. The analysis of banana plant kinship can be represented in a dendrogram, where proximity on the dendrogram indicates a high level of similarity in identification.

Given the limited information available about the local Ambon banana in Rejang Lebong, it is essential to conduct a morphological characterization of this variety. This study aims to: (1) conduct a morphological characterization of different local Ambon banana genotypes in Rejang Lebong, Bengkulu Province, and (2) determine the kinship among the local Ambon banana genotypes in Bengkulu's Rejang Lebong district.

MATERIALS AND METHOD

This characterization and identification process was conducted from September to December 2019 in various villages and sub-districts within the Rejang Lebong district. The study materials consisted of banana plant samples, and the tools used included a tape measure, scale, labels, color charts, a 16 MP Sony digital camera, and stationery. The research design employed a direct survey method, as the study is descriptive. Data was collected through interviews with farmers and banana collectors, as well as observations and measurements of the generative phase banana plants sampled in the selected areas.

This study employed a survey method with purposive sampling to gather data on the morphological characteristics of the local Ambon banana in the Rejang Lebong Regency. The samples were taken from banana plants that were approximately 1-2 years old.

The implementation procedure includes two main steps: (1) retrieving secondary data from the Agriculture Service of Rejang Lebong Regency, and (2) collect primary data in the

field by distributing questionnaires to several banana farmers and direct surveys to the field by observing, observing, measuring, interpreting, and asking farmers about everything related to the observation parameters.

The observation covers the following issues which were related to: (1) the location of banana plants, (2) names of Banana, (3) condition of stems—if it was pseudo stems or stems from the largest clumps, and (4) the leaf.

During observation of the pseudo stems, several morphological elements were taken into consideration, such as: (1) pseudo stem height; which was measured when the plant had oval fruit, and which was measured from the base of the pseudo stem to the base of the bunch or frond, (2) pseudo stem color (in cm), (3) pseudo circle (in cm), the pseudo-stem circle was measured ± 50 cm from the top between the stump and the pseudo-stem by wrapping a rope around the trunk circle and then measuring the rope. The length of the

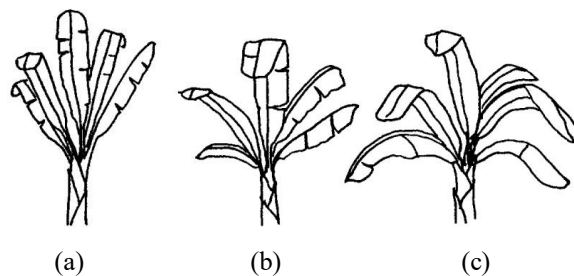


Figure 1. Leaf shape (a) upright, (b) semi-upright, and (c) hanging.

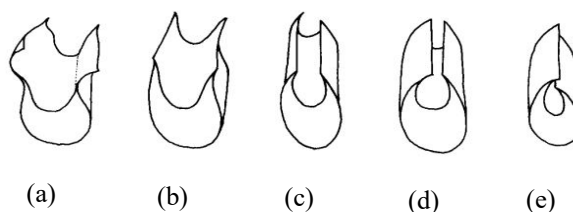


Figure 2. The shape of petiole tip; (a) open with fluffy sides, (b) wide with straight sides, (c) straight with straight sides, (d) side bend inward, and (e) the sides cover each other.

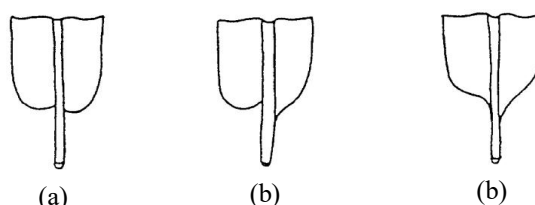


Figure 3. The basic shape of the leaf bones; (a) both sides are rounded, and (b) one side is rounded, and the other is pointed

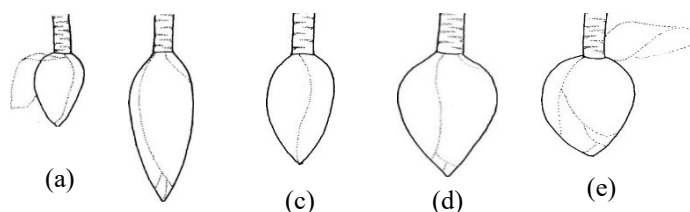


Figure 4. Heart shapes; (a) small, (b) long as a knife, (c) medium, (d) ovoid, and (e) round

string was the apparent circle of the rod, and also (4) original stem circle.

The morphological elements of leaf include (1) leaf shape; whether it was upright, semi-upright, or hanging, (2) the length of the petiole, observed from the base of the petiole to the tip of the petiole, (3) the shape of the petiole tip, (4) the basic shape of the leaf bones, (5) The length of the longest leaf blade that was selected from the longest leaf by measuring from the base to the lamina tip, (6) the color of the leaves' upper surface, (7) leaf surface (rough, slippery), (8) banana heart or banana inflorescence and (9) the fruit.

Some observed elements of fruits were (1) fruit skin color, (2) type and the use of fruit—whether it was for table fruit, processed or cooked fruit, (3) number of hands per bunch, (4) the highest number of fruit per hand, (5) age of harvest from flowering months, (6) the length of the largest fruit (in cm), (7) the largest fruit circle(in cm), and (8) the weight of the largest and the most extended fruit.

RESULTS AND DISCUSSION

Stem Characterization

The morphological characterization of the stems of 7 local Ambon banana species in Rejang Lebong revealed distinct variations in their morphological features. The findings of the stem morphological characterization were compiled and presented in Table 1, which provides an overview of the morphological characteristics of the local Ambon banana stems in Rejang Lebong.

As seen in Table 1, there are variations in the color of the pseudo stem and pseudo stem spots on the 7 Ambon bananas. These observations were made using the Color Chart. The color of local Ambon banana stems in Rejang Lebong is shown in Figure 5.

Qualitative Data of Local Ambon Bananas

Table 2 illustrates the variations in the edge of the leaf sheath for three local Ambon banana varieties found in Rejang Lebong. These variations include winged and clamped to the stem, winged and not attached to the stem, and winged and wavy. *Ambon Kuning* and *Ambon Hijau* varieties feature winged and clamped stems, while *Ambon Putih* variety displays winged stems that are not clamped. *Ambon Rejang (Ambon Pendek)* variety is unique because it displays a winged and wavy edge on the leaf sheath (Figure 6).

Tabel 1. Morphological Characteristics of Rejang Lebong Local Ambon Banana Stems

No.	Name of Local Ambon Banana	Stem Height (m)	Pseudo Stem Color	Spot on the Pseudo-stem	Circumference of Pseudo-stem (cm)	Stump Circle (cm)
1.	<i>Kuning</i>	5	Green and Brown with Black Spots5 GB 7/4	Brown (5YR 6/4)	78	110
2.	<i>Hijau</i>	6.50	Dark Green 5 G 7/6	Dark Brown 5 YR 6/4	87	98
3.	<i>Putih</i>	6	Yellowish Green 5 GY 7/4	Dark Brown 5 YR 6/4	85	103
4.	<i>Dingin</i>	4	Fair Green 5 G 6/4	Subdued Brown 5 YR 7/6	91	73
5.	<i>Pendek (Kapal)</i>	2	Fair Green 5G 6/4	Brown 5 YR 6/4	61	74
6.	<i>Lumut</i>	6.30	Yellowish Green 5 GY 6/6	Grayish Brown	86	93
7.	<i>Curup</i>	5.5	Greenish Brown 5 GB 7/5	Brown (5YR 6/4)	81	105

Table 2. Morphological Characterization of Leaves of Local Ambon Banana in Rejang Lebong

No.	Name of Local Ambon Banana	Wax on Leaves	KD	WTPD	KTPD	BPD	TK	BPPPD	WPAD	WPBD	PD
1	Kuning	High Wax	Upright	Pale Purple-Red	Winged and not clamping the stem	One side rounded	Open with vertical edges	Dark Brown	Dark Green	Dark Green	Dull
2	Hijau	High Wax	Medium	Pale Purple-Red	Winged and not clamping the stem	One side rounded	Open with lateral spreading edges	Dark Brown	Green	Dark Green	Dull
3	Putih	Sufficient Wax	Medium	Pinkish-purple	Winged and not clamping the stem	Both sides rounded	Open with lateral spreading edges	Dark Brown	Dark Green	Green	Sparkling
4	Dingin	Low Wax	Semi-Upright	Green	Winged and not clamping the stem	Both sides rounded	Open with vertical edges	Reddish-Brown	Dark Green	Medium Green	Sparkling
5	Pendek/Kapal	High Wax	Medium	Pink	Winged and wavy	Both sides rounded	Open with lateral spreading edges	Subdued Brown	Dark Green	Fair Green	Dull
6	Lumut	High Wax	Medium	Green	Winged and not clamping the stem	One side rounded	Open with lateral spreading edges	Dark Brown (slightly)	Green	Medium Green	Dull
7	Curup	High Wax	Upright	Pinkish-purple	Winged and clamping the stem	One side rounded	Open with vertical edges	Dark Brown	Green	Dark Green	Dull

Remarks: KD (leaf uprightiness), WTPD (edge color of leaf sheath), KTPD (condition of leaf sheath edge), BPD (leaf base shape), TK (vein type), BPPPD (spots on leaf sheath base), WPBD (color of leaf sheath spots), WPAD (color of upper leaf surface), WPBD (color of lower leaf surface), PD (leaf sheath base).

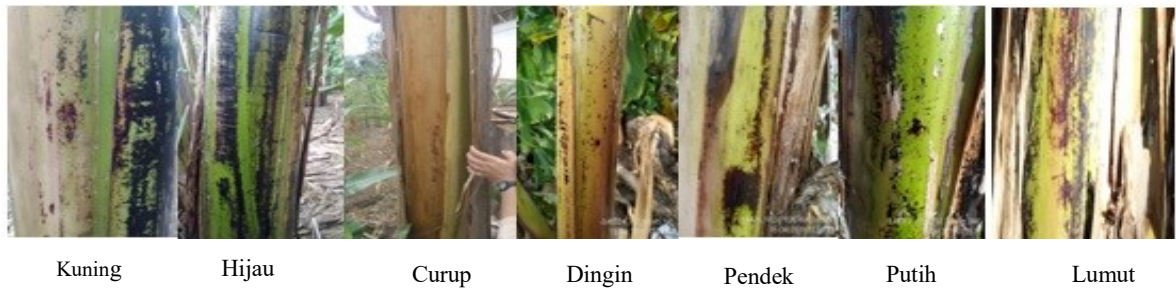


Figure 5. The color of pseudo-stems and spots on pseudo-stems of local ambon banana in Rejang Lebong

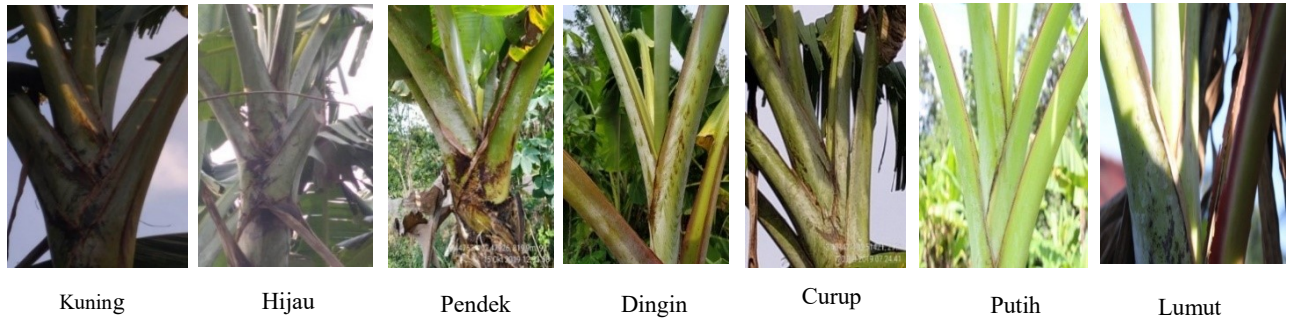


Figure 6. The shape of the edge of the banana leaf sheath of local Ambon bananas in Rejang Lebong is (a) winged and clamping the stem; (b) winged and not clamping the stem; and (c) winged and wavy

Figure 7 shows the form of the leaf base from seven indigenous *Ambon Curup* banana genotypes. It consists of one side rounded and both sides rounded. One side rounded is seen in *Ambon Kuning*, *Ambon Hijau*, and *Curup* types. While both sides rounded is seen in *Ambon Putih*, *Ambon Dingin*, and *Ambon*

Rejang types.

The leaf spot type consists of an open with a side spreading edge, a vertical edge, and a side expanding, and a closing edge. The leaf spot type of the Bengkulu's local Ambon banana is presented in Figure 8 below.

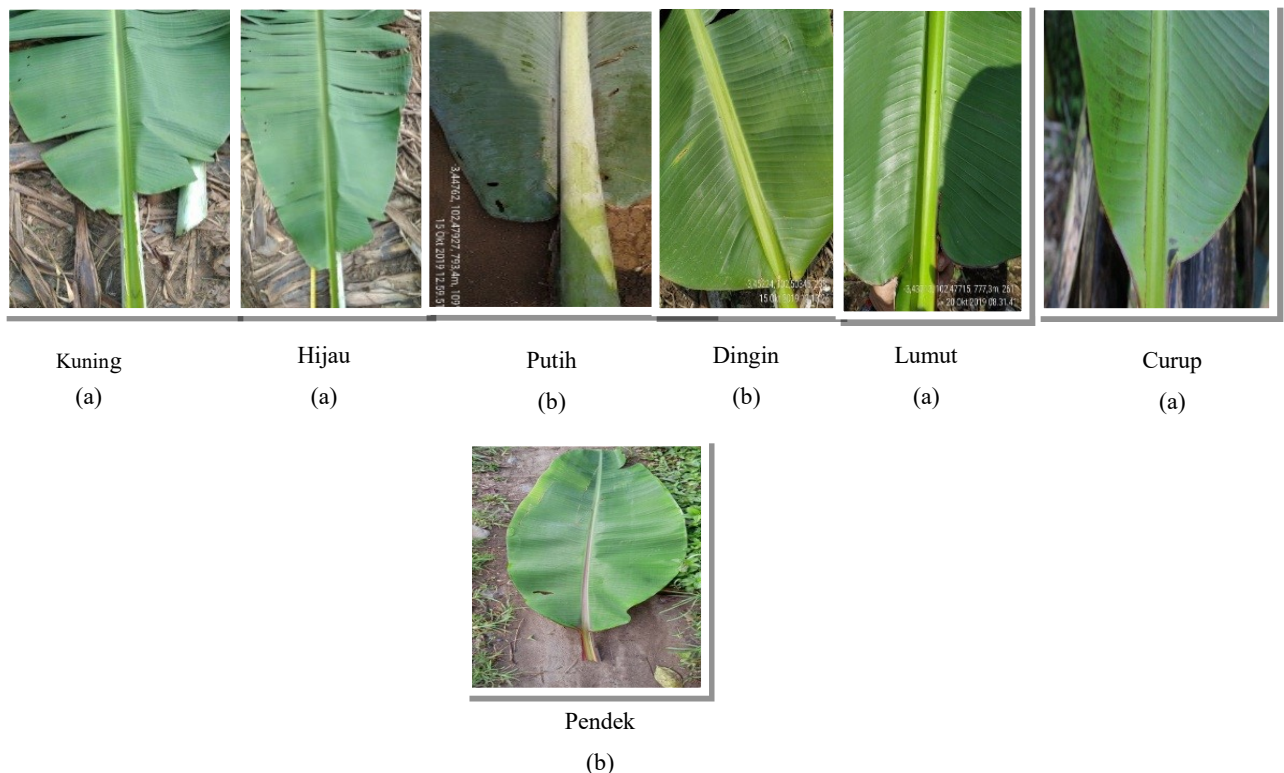


Figure 7. The shape of the leaf base is: (a) one side rounded, (b) both sides rounded

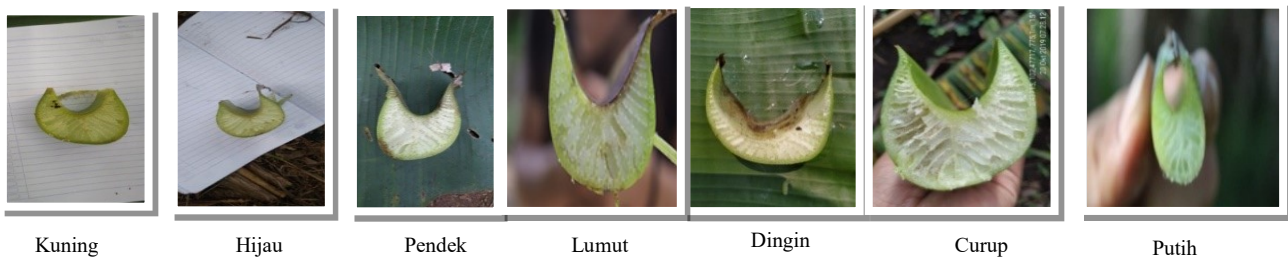


Figure 8. Leaf Spot Type of 7 Curup (Local Ambon).

Characterization of the Banana Heart

The banana heart, or pseudo stem, serves as the core of the stem of the banana plant. Layers of tightly wound leaf sheaths that surround the plant's growing tip make up the banana heart. The sheath's inner layer offers structural support and carries nutrients to the growing tip, while the outermost layer produces a protective covering for the budding buds and flowers. Some species of banana blooms may grow up to 9 meters tall, and they are typically green in color. The banana plant's heart, which promotes the growth and development of stems that bear fruit, is an essential component.

The shape of banana inflorescence varies, including long and round like a spear, round like an egg, and medium-sized. The average color of the heart is dark red (Figure 9).

Characterization of Local Ambon Banana Morphology

The variety of bananas grown in Indonesia are renowned for their wide range and distinct physical traits. In Indonesia, there are many different types of banana plants, each with a unique pseudostem that varies in thickness, height, and color. While some banana cultivars have red or purple pseudostems, others have green pseudostems.

The Quantitative Data of Local Ambon Bananas

Table 5 shows that the quantitative data on leaf shows that the green ambon gives the longest leaf width of 90 cm and the longest strand length of 354 cm

Relationship Analysis

After being carried out using Minitab Program, the kinship relationship of the Local Ambon Banana is shown in Figure 11.

Rejang Lebong consists of 3 kinship groups, namely Group one consisting of Ambon Kuning (1), Ambon Curup (7), Ambon Hijau (2) and Ambon Lumut (6), group 2 namely Ambon Pendek (5), group 3, namely Ambon Putih (3), and Ambon Dingin (4). The closest kinship is between Ambon Kuning (1) and Curup (7), with a similarity level of 93.67, while amboncurup has the furthest degree of kinship, ambonpendek (5), which is 48.37. For more details, the degree of similarity can be seen in Table 6.

Table 6 above shows that the types of Ambon bananas that are most closely related are Ambon Kuning and Ambon Curup, with a degree of kinship of



Figure 9. The shape of the banana inflorescence: (a). Medium shape, (b) Long Spear-Like Shape, (c). Egg-Like Shape

Table 3.Characterization of the Banana Heart Morphology of the Local Ambon in Rejang Lebong

No	Names of Banana	Flowering Age(in Days)	The shape of Banana Heart	Color of Banana Heart
1	Ambon Kuning	303	Long and Round Spearlike	Dark Red 10 R 6/7
	Ambon Hijau	290	Medium	Dark Red 10 R 6/7
3	Ambon Putih	297	Round Egglike	Dark Red 10 R 6/7
4	Ambon Dingin	280	Medium	Dark Red 10 R 6/7
5	Ambon Pendek	300	Medium	Red 10 R 6/2
6	Ambon Lumut	290	Medium	Dark Red 10 R 6/7
7	Ambon Curup	300	Long and Round Spearlike	Dark Red 10 R 6/7

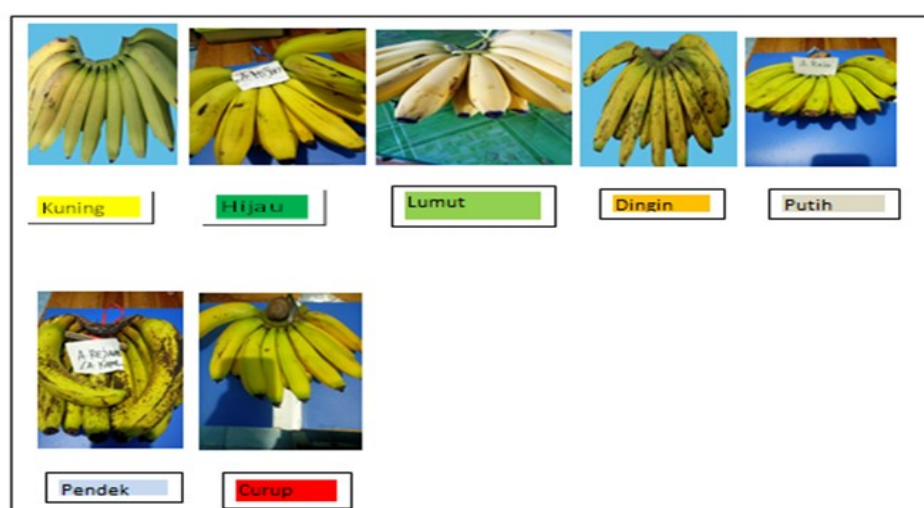


Figure10.The Morphology of the fruit of 7 Bengkulu's local Ambon.

Table 4. Characterization of Local Ambon Morphology

No	Genotype	Ripe fruit skin color	Fruit usage	Number of fruit	Number of tier per	Days to	Fruit length	Fruit diameter	Weight per fruit
1.	Ambon Kuning	Yellow	Tabel Fruit	11	20	3	17	33.93	86.95
2.	Ambon Hijau	Green and Yellow	Tabel Fruit	9	26	3	19	36.73	146.5
3.	Ambon Putih	Yellow	Tabel Fruit	9	20	3.5	16	32.56	82.34
4.	Ambon Dingin	Green and Yellow	Tabel Fruit	7	17	4	15	32.97	111.89
5.	Ambon Pendek/Kapal	Yellow	Processed	9	23	3	16	31.22	81.34
6.	Ambon Lumut	Green and Yellow	Tabel Fruit	9	24	3	9	36.22	125
7.	Ambon Curup	Yellow	Tabel Fruit	10	18	3	18	34.22	87.65

Table 5. Measurement of Ambon Banana leaves in Rejang Lebong Regency.

Jenis Pisang	Leaf Width (cm)	Leaf Stem Length (cm)	Leaf Length (cm)	Leaf Width (cm)
<i>Ambon Kuning</i>	86	52	350	43
<i>Ambon Hijau</i>	90	61	354	40
<i>Ambon Putih</i>	62	58,2	164	30
<i>Ambon Dingin</i>	56	38,9	158	18
<i>Ambon Pendek/Kapal</i>	70	31	258	40
<i>Ambon Lumut</i>	42	85	285	21
<i>Ambon Curup</i>	83	47	340	43

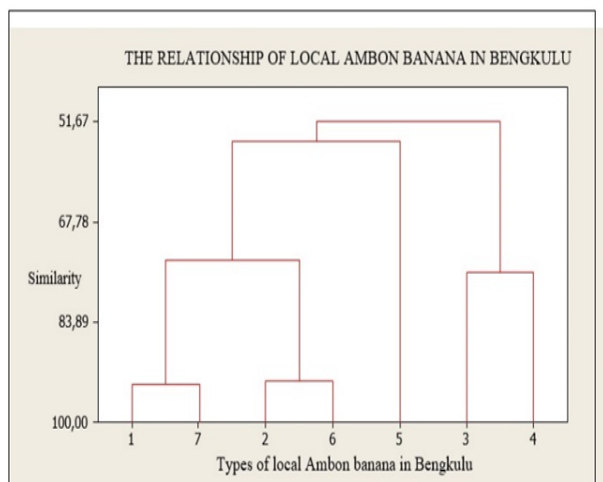


Figure 11. Relationship of the local ambon banana based on morphological characters

93.67. Meanwhile, Ambon Pendek has the most distant similarity, of 48.37.

Discussion

The morphological properties of plants include stems, flowers, leaves, and fruit. These parts will be used as a reference in identifying and mapping their kinship relationships. However, the morphological properties are considered limited due to the significant environmental influences. This condition needs to be more accurate at the time of identification. These changing environmental conditions will cause high genetic diversity (Sultan, Kadekoh, and Sahiri, 2016) and (Hutami, Mariska, and Supriati, 2016).

Morphological characterization of banana plants is needed to assemble superior varieties by identifying existing germplasm sources. However, morphological characters are considered insufficient to find a clear position, so other methods must be applied.

Table 6. Level of kinship of Rejang Lebong's Ambon bananas.

No	Level of Kindship	Categorization
1	93,67	1 – 7
2	93,50	2 - 6
3	48,37	5
4	76,75	3 – 4

The use of characterization can use samples from all parts of the plant body with few quantitative numbers; this is because the DNA in the plant body is found in all parts of the plant with the same pattern. However, due to unstable environmental factors, morphological and physiological changes often occur to the external characters produced by plants, so errors often occur in formulating an identification and kinship analysis of a plant.

According to Y. H. Wang, Cai, Wang, & Lin, (2019), the different levels of diversity are caused by morphological appearance, number of chromosomes, and geographical location. The diversity of bananas can be distinguished based on the fruit's taste, shape, and color. Populations with high genetic diversity have better life chances because they can adapt to their environment (Hutami, Mariska, and Supriati, 2016).

CONCLUSION

The kinship relationship for each type of local banana, Ambon Curup consists of 3 kinship groups, the first group is *Ambon Kuning*, *Curup Ambon*, *Ambon Hijau* and *Ambon Lumut*, and the second group; *Ambon*

Pendek, and the third group; *Ambon Putih*, and *Ambon Dingin*. The closest kinship is between *Ambon Kuning* and *Ambon Curup*, with a similarity level of 93.67%, while *Ambon Curup* have the furthest degree of kinship, namely *Ambon Pendek*, which is 48.37%.

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