

# Assessment of morphological, molecular diversity, proximate and sensory properties of superior local durian in Jember District, East Java, Indonesia

VEGA KARTIKA SARI<sup>1,\*</sup>, NURVITTA PRAKASA AGUSTIN IRIAWATI<sup>1</sup>, RIZA YULI RUSDIANA<sup>1</sup>,  
HALIMATUS SA'DIYAH<sup>1</sup>, SLAMETO<sup>1</sup>, BASUKI<sup>2</sup>

<sup>1</sup>Department of Agronomy, Faculty of Agriculture, Universitas Jember. Jl. Kalimantan 37, Jember 68121, East Java, Indonesia.

Tel.: +62-331-334054, \*email: [vegakartikas@unej.ac.id](mailto:vegakartikas@unej.ac.id)

<sup>2</sup>Department of Soil Science, Faculty of Agriculture, Universitas Jember. Jl. Kalimantan 37, Jember 68121, East Java, Indonesia

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**Abstract.** Sari VK, Iriawati NPA, Rusdiana RY, Sa'diyah H, Slameto, Basuki. 2026. Assessment of morphological, molecular diversity, proximate and sensory properties of superior local durian in Jember District, East Java, Indonesia. *Asian J Agric* 10 (1): g100126. <https://doi.org/10.13057/asianjagric/g100126>. One of the most valuable fruits in Indonesia is durian (*Durio zibethinus*). The Pantu District in Jember District, East Java, Indonesia, offers an ideal combination of climatic and geographical conditions conducive to durian cultivation. This study aimed to investigate the superior local durian's morphological, molecular, proximate, and sensory diversity. Nine accessions of durian were collected from Pantu District. Qualitative characters were evaluated using the Shannon-Wiener diversity index, while quantitative characters were analyzed descriptively to assess morphological diversity. Molecular variation was examined using Random Amplified Polymorphic DNA (RAPD) markers, proximate composition was determined for fruit flesh and seeds, and sensory attributes (taste, aroma, color, texture) were assessed. Results showed coefficients of variation for 10 quantitative characters ranging from 11.47 to 43.3% (low to rather low), and diversity indices for 28 qualitative characters ranging from 0.349 to 1.465 (low to moderate). Five superior durian cultivars from the Pantu Jember cluster formed two groups with approximately 30% genetic similarity. The proximal content of durian accessions varies due to differences in genetic material. Sensory tests have high diversity in texture and color characters, which are critical factors influencing consumer preference. These findings provide a basic data for developing effective conservation and breeding strategies to support sustainable durian cultivation.

**Keywords:** Diversity, durian, Jember, molecular, morphology

## INTRODUCTION

Durian (*Durio zibethinus*) is a tropical fruit native to Sumatra and Borneo (POWO 2026). This fruit is commonly known as the "king of fruits" and is known for its high nutritional content. It contains between 84-185 kcal of energy, 15.65 to 34.65 g of carbohydrates, 1.40 to 3.50 g of protein, and total sugars ranging from 3.10 to 19.97 g in 100 g of durian, depending on the variety (Khaksar et al. 2024). In addition, durian also contains bioactive compounds, such as polyphenols and vitamins. According to Aziz and Jalil (2019), the total polyphenol in durian ranges from 21.44 to 374.30 mg, and the anthocyanin ranges from 0.32 to 633.44 mg.

Indonesia is a diversity center of durian with more than a hundred cultivars recognized as superior durians (Angelienna et al. 2019). Durian grows in various regions of Indonesia, each with its own unique qualities, making it one of the most genetically diverse fruit commodities (Christie and Lestari 2019). East Java Province is one of the largest producers of durians in Indonesia, with a total production of 276,426 tonnes (24.20%) (Sari et al. 2024), and is known to have many local durian accessions with superior quality for taste and fruit. These local accessions need attention, especially in terms of development and

conservation. Durian has diverse morphological characters (Widayanti et al. 2021). According to Belgis et al. (2016), the diversity of durian lies in the taste, aroma, texture, and color of the fruit flesh, as well as the shape and size of the fruit. Identification based on morphology is initial information on plant genetic diversity. However, morphological characters are strongly influenced by environmental conditions (Wu et al. 2021).

Due to limitations in morphological characters, molecular characters are needed to detect its diversity, such as Random Amplified Polymorphic DNA (RAPD). The advantages of RAPD markers encompass their straightforwardness, as they require a comparatively simple preparatory procedure, the application of arbitrary primers without the necessity for genetic DNA data or preliminary genomic sequences, the swift attainment of results, and the ability to produce a varied range of phenotypic traits. It is very helpful to analyze the genetic variability of plant species whose genomic backgrounds remain uncharacterized (Lizawati et al. 2019). RAPD analysis was the preferred as the initial method for genetic fingerprinting due to its simplicity, low-cost, needed only a small quantity of DNA (Hannum et al. 2020). However, the disadvantages of the markers are less reliable and inappropriate for Marker-Assisted Selection (MAS) due to their constraints,

which include a short primer length, reduced polymorphism levels, non-reproducible PCR results, and the dominant mode of inheritance (Bidyananda et al. 2024). Nevertheless, RAPD is still widely used to assess genetic diversity in various plant species, such as durian from Nias Island (Hannum et al. 2020), Tidore Island, (Sundari et al. 2021), mango (*Mangifera indica*) (Anggraheni and Mulyaningsih 2021), and matoa (*Pometia pinnata*) (Zulfahmi et al. 2023).

Testing the proximate content of durian fruit flesh and seeds is also necessary as durian is frequently utilized as a processed food items (Rusmiati et al. 2021). Besides, consumer preferences are crucial. Studies on fruit taste, quality, and preference consumer are necessary to promote the durian locally from Jember, East Jawa, successfully. Kim et al. (2023) stated the flavor quality is driven by the chemical composition of fruit, which important clue for breeding selection. This study aimed to assess the morphological, molecular, proximate, and sensory diversity of superior local durians in Jember District, which is expected to support future conservation, cultivar development, and local market competitiveness.

## MATERIALS AND METHODS

### Study area

This research was conducted in the Pakis Village, Panti District, Jember District, East Java, Indonesia (Figure 1 and Table 1). It used a survey method, and the sampling technique used was purposive sampling. The purposive sampling was based on certain criteria, such as durian plants being at least 25 years old, having borne fruit multiple times, possessing desirable traits, and being favored by the local community (Sihaloho et al. 2021). The durian sampling locations in two hamlets of Pakis Village were determined based on input from community members,

plant collectors, and local sellers. Locally, durian varieties are typically named according to the distinctive characteristics of their fruit (Christie and Lestari 2019). Panti district residents name fruits based on their shape, origin, and the wishes of the local community.

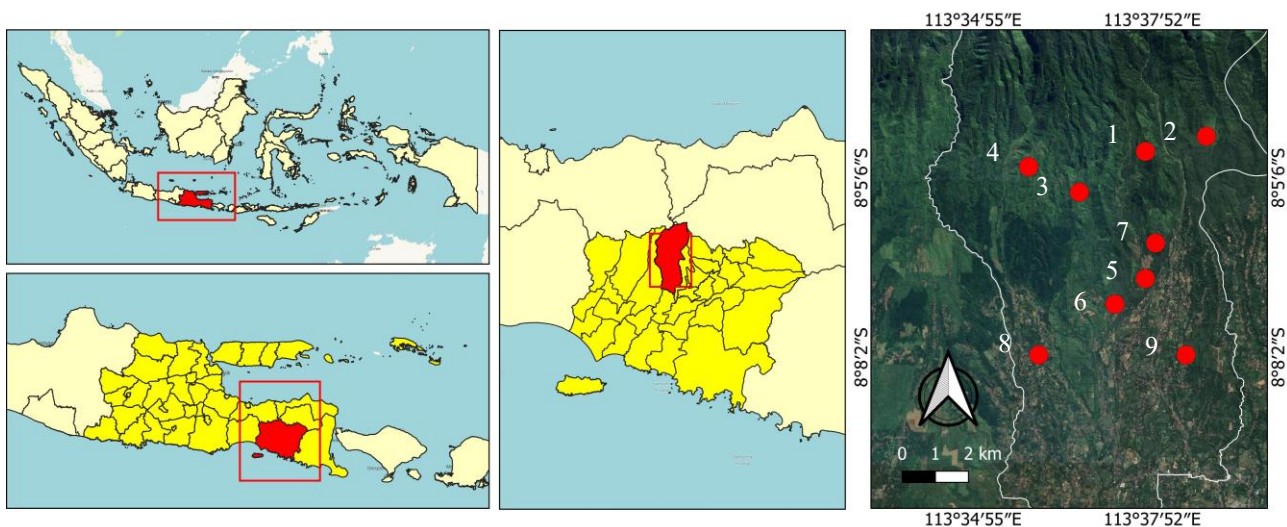
### Plant materials

The nine accessions of durian were collected from two hamlets in the Pakis Village, Panti District, Jember District, East Java (Table 1). A number of these accessions were characterized morphologically. Meanwhile, for other analyses, such as molecular analysis, there were only 5 accessions, and for proximate and sensory analysis, there were 7 accessions. The difference in numbers is due to the availability of fruit and funds for analysis.

### Procedures

#### Morphological observation

The morphological characters observed included 28 qualitative and 10 quantitative characters in 9 durian plants tested, including the stem, leaves, fruit, and seeds. The qualitative characters were trunk surface, crown shape, the growth habit, bark color, leaf upper surface color, leaf lower surface color, leaf attitude, leaf blade length, leaf blade width, leaf blade shape, leaf apex shape, leaf base shape, fruit shape, shape of fruit apex, shape of fruit base, fruit stalk length, fruit spine shape, fruit weight, fruit skin/rind color, aril thickness, aril texture, flesh taste, flesh aroma, flesh color, number of carpels per fruit, seed shape, and seed coat color. The quantitative characters were tree height, stem height, stem circumference, petiole length, petiole width, fruit length, fruit diameter, seed weight, seed length, and seed width. The morphological characterization of the durian plant was observed and identified using the Descriptors for Durian (Bioversity International 2007).



**Figure 1.** The study site in Panti District, Jember District, Indonesia

**Table 1.** Superior local durian obtained from Panti District, Jember District, Indonesia

No	Local cultivar	Abbreviation	Location (Village and Hamlet)	Coordinate point (E; S)
1	Si Jonggrang	SJ	Pakis, Pakis	113°37'45"; 8°4'40"
2	Gendon 1	GD1	Pakis, Pakis	113°38'45"; 8°4'25"
3	Montong Belanda 1	MB1	Pakis, Pakis	113°36'40"; 8°5'20"
4	Rondo Kedutan	RKD	Pakis, Pakis	113°35'50"; 8°4'55"
5	Lokal Kois	LK	Pakis, Pakis	113°37'45"; 8°6'45"
6	Montong Belanda 2	MB2	Pakis, Pakis	113°37'15"; 8°7'10"
7	Si Babi	SB	Pakis, Kemundungan	113°37'55"; 8°6'10"
8	Si Mas	SM	Pakis, Kemundungan	113°36'0"; 8°8'0"
9	Gendon 2	GD2	Pakis, Kemundungan	113°38'25"; 8°8'0"

### Molecular analysis

The molecular characters were carried out on 5 durian plants using leaf samples from each plant, which were analyzed based on two RAPD markers. Stages in molecular observations include DNA extraction and amplification. DNA was extracted using the CTAB method developed by Doyle and Doyle (1990) with modification, where the extraction buffer composed of 100 mM Tris-HCl pH 8.0, 1.4 M NaCl, 20 mM EDTA pH 8.0, 2% CTAB, 2% PVP, and 0.38% natrium bisulfite.

The DNA was then PCR amplified in a total reaction volume of 10 µL containing 2 µL of DNA template, 5 µL of 2x MyTaq HS, 1 µL of RAPD primer, and 2 µL sterile ddH<sub>2</sub>O. The RAPD primers used in the study were OPP-09 (5'-GTGGTCCGCA-3') and OPE-20 (5'-AACGGTGACC-3'). Amplification was performed using a T100 Thermal Cycler (BioRad, USA) programmed with an initial denaturation at 95°C for 5 minutes; 45 cycles for denaturation at 94°C for 30 seconds; annealing at 36°C for 1 minute; extension at 72°C for 1 minute; and a final extension at 72°C for 7 minutes. The amplification results were then electrophoresed on a 1.5% agarose gel in a tank containing 1x TBE (Tris Borate EDTA) buffer at 100 volts for 25 minutes. The gel was stained with ethidium bromide solution (10 mg/mL) and visualized using a UV transilluminator (BioRad, USA).

### Proximate and sensory properties observation

Only 7 durian plants were used in the proximate analysis and sensory tests, because the fruits on the other 2 plants had not reached physiological maturity and were not harvestable at the time the study was conducted. Proximate test was carried out on durian fruit and seeds, where the durian fruit was tested for water content, fat, and carbohydrates, while the durian seeds were tested for water content and carbohydrates. Analysis of water content and fat used the gravimetric method, and n-hexane solvent was added to the fat content test. The gravimetric method is a standard laboratory technique that is widely used (Werneck and Werneck 2014). While for carbohydrate analysis, DNS (Dinitrosalicylic acid) was used in accordance with the Association of Official Analytical Chemists (AOAC) (2007). The variation in the number of samples analyzed was adjusted according to the availability of fruit at the time the study was conducted.

Sensory characters were carried out to determine the level of liking or disliking of the durian fruit. Durian plants

were sensory tested with the help of 10 panelists consisting of men and women (aged 25-35 years). Tests were carried out at room temperature and room light. Panelists received instructions regarding the assessment scale and procedures before the testing was carried out. Between samples, mineral water was provided to panelists to clean their palates. Panelists were also instructed to take some fresh air before moving on to the next sample. Variables assessed included taste, texture, aroma, and color using a 6-point hedonic scale: 1: extremely dislike, 2: dislike, 3: neutral, 4: moderately like, 5: like, and 6: extremely like. The testing method was conducted as described by Lim et al. (2025).

### Data analysis

The morphological data were analyzed descriptively to identify the variations in the character. Quantitative characters were analyzed for minimum, maximum, mean, and coefficient of variation. Coefficient of variation was one common variability measure, which expressed the standard deviation as a proportion of the mean and did not depend on the unit scales (Santos and Dias 2021). The aim of using the coefficient of variation is to observe the distribution of data from the average data obtained. Qualitative characters were analyzed using the Shannon-Wiener diversity index, while quantitative characters were analyzed descriptively with minimum, maximum, average, and coefficient of variation values. The Shannon index was used to calculate the descriptor's entropy level (Marcon et al. 2014) as follows:

$$H' = - \sum_{i=1}^n p_i \ln p_i$$

Where: n was the total number of phenotypic classes for a character, and P<sub>i</sub> was the proportion of genotypes that had the character in the class for a character. Software Microsoft Excel was used to calculate the quantitative morphological trait frequency, distribution, and Shannon-Wiener diversity Index values.

Molecular characteristics presented results visually assessed as binary data, in which each visible band was scored 1, while the invisible band was scored 0. Clustering was done using the Jaccard similarity coefficient and cluster obtained was based on Unweighted Pair Group Method for Arithmetic mean (UPGMA) using sequential agglomerative hierarchical nested (SAHN) cluster analysis of NTSYS-PC version 2.1. The sensory characteristics were analyzed using Multidimensional Scaling (MDS), a multivariate statistical technique that translates complex

similarity or dissimilarity data among samples into a spatial representation. This analysis was a multiple-variable technique used to determine the position of another object based on an assessment of its similarity (Delialioğlu et al. 2022).

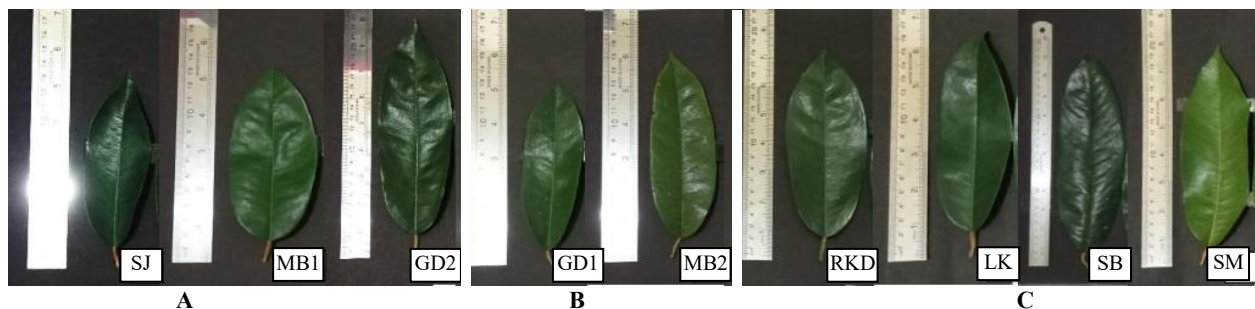
## RESULTS AND DISCUSSION

### Morphological diversity

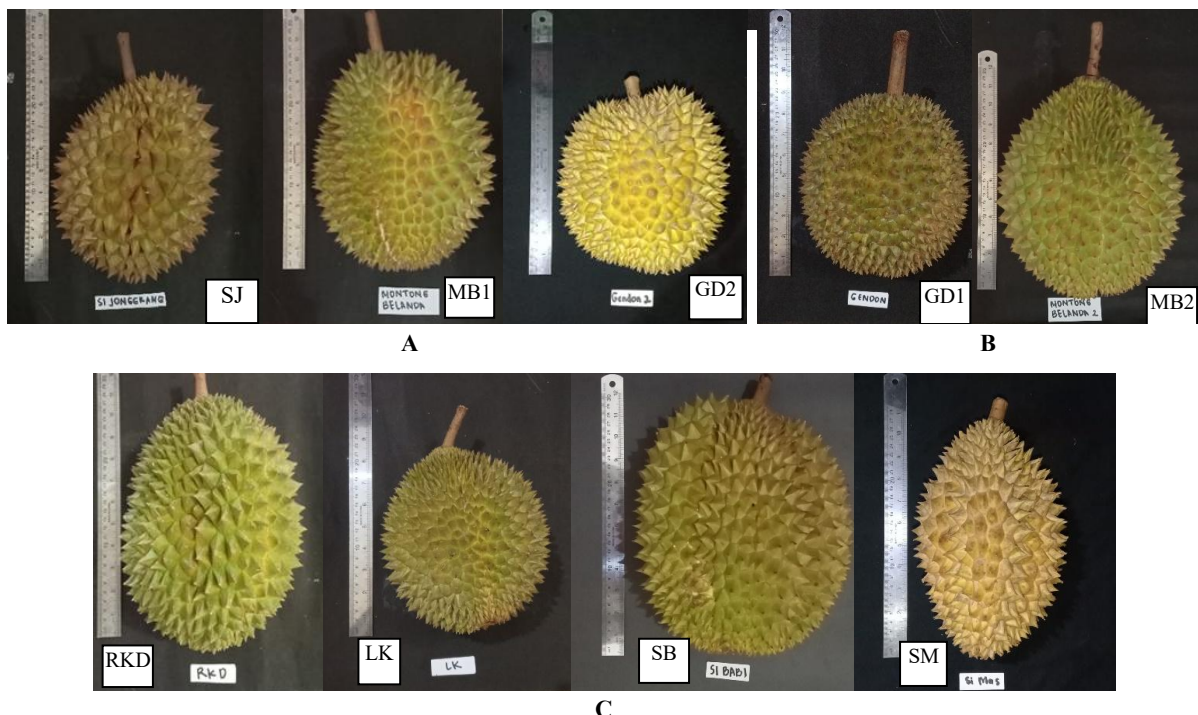
The durian plants in Panti District that were obtained were then observed for their morphology, including 28 qualitative characters, which included the morphology of stems, leaves, fruit, and seeds, and 10 quantitative characters. High variation in morphological characters will result in a high diversity index value and vice versa. The results of the Shannon-Wiener diversity Index analysis for each observed character are presented in Table 2. According to Magurran (1988), the Shannon-Wiener diversity Index ( $H'$ ) criteria are classified as follows: low diversity ( $H' < 1$ ), moderate diversity ( $1 < H' < 3$ ), and high diversity ( $H' > 3$ ). Based on this classification, most characters exhibit low to moderate diversity ( $H' < 3$ ),

indicating that the accessions are relatively similar in several morphological characters.

Individual qualitative morphological characters calculated by Shannon-Wiener diversity Index ( $H'$ ) values ranged from 0.349 (fruit spine length) to 1.465 (fruit skin color), with a mean value of 0.909 for all characters (Table 2). Characters related to vegetative (such as crown shape and leaf blade shape) and fruit-related (such as fruit shape, shape of fruit apex, shape of fruit base, fruit spine shape, fruit skin, flesh taste, and seed shape) generally show moderate diversity, suggesting variation influenced by environmental factors or local adaptation. Two example characters, namely variation of leaf blade shape and fruit shape are presented in Figures 2 and 3, respectively. In contrast, other characters in this study display low diversity, indicating that these characters are more stable and genetically conserved among the accessions studied. High diversity index values show that the character is more polymorphic and diverse among the genotypes tested, whereas low values indicate the character is less polymorphic and hence less diverse (Gemeda et al. 2022).



**Figure 2.** Variation of leaf blade shape: A. Elliptic (SJ, MB1, GD2); B. Oblong (GD1, MB2); C. Linear-oblong (RKD, LK, SB, SM)



**Figure 3.** Variation of fruit shape: A. Elliptic (SJ, MB1, GD2); B. Oblong (GD1, MB2); C. Linear-oblong (RKD, LK, SB, SM)

**Table 2.** Diversity index of qualitative morphological characters

Character	Category	Frequency (%)	Diversity Index (H')
Trunk Surface	1 smooth	0	0.530
	2 rough	78	
	3 very rough	22	
	4 flaky	0	
Crown Shape	1 pyramidal	0	1.311
	2 oblong	0	
	3 spherical	33	
	4 semi-circular	11	
	5 elliptical	22	
	6 irregular	33	
The Growth Habit	1 erect	11	0.849
	2 intermediate	67	
	3 spreading	22	
Bark Color	1 grey	11	0.849
	2 brown	67	
	3 dark brown	22	
Leaf Upper Surface Color	1 light green	11	0.849
	2 green	22	
	3 dark green	67	
	4 brownish green	0	
Leaf Lower Surface Color	1 silvery brown	44	0.687
	2 coppery brown	56	
Leaf Attitude	1 semi-erect	56	0.687
	2 drooping at 45°	44	
	3 dropping vertically	0	
Leaf Blade Length	1 short	0	0.637
	2 intermediate	67	
	3 long	33	
	4 very long	0	
Leaf Blade Width	1 narrow	0	0.530
	2 intermediate	78	
	3 wide	22	
	4 very wide	0	
Leaf Blade Shape	1 obovate-lanceolate	0	1.061
	2 oblong	22	
	3 linear-oblong	44	
	4 elliptic	33	
	5 ovate	0	
	6 obovate	0	
Leaf Apex Shape	1 acute	56	0.937
	2 acuminate	33	
	3 long acuminate	11	
	4 caudate	0	
	5 cuspidate	0	
Leaf Base Shape	1 round	22	0.995
	2 obtuse	0	
	3 acute	22	
	4 cuneate	56	
	5 cordate	0	
Fruit Shape	1 oblate	0	1.273
	2 globose	44	
	3 oval	22	
	4 oblong	22	
	5 elliptic	11	
	6 obovoid	0	
	7 ovoid	0	

Character	Category	Frequency (%)	Diversity Index (H')
Shape of Fruit Apex	1 pointed	33	1.311
	2 convex	33	
	3 mammiform	0	
	4 truncate	22	
	5 depressed	11	
Shape of Fruit Base	1 depressed	0	1.273
	2 necked	0	
	3 convex	44	
	4 truncate	22	
	5 concave	11	
	6 acute	22	
Fruit Stalk Length	1 short	22	0.530
	2 medium	78	
	3 long	0	
Fruit Spine Shape	1 hooked	11	1.273
	2 convex	0	
	3 pointed-convex	0	
	4 concave	22	
	5 pointed-concave	22	
	6 conical	0	
	7 pyramidal	44	
Fruit Spine Length	1 short	0	0.349
	2 intermediate	89	
	3 long	11	
Fruit Weight	1 very light	0	0.995
	2 light	22	
	3 medium	56	
	4 heavy	22	
	5 very heavy	0	
Fruit Skin/Rind Color	1 green	0	1.465
	2 brownish green	33	
	3 yellowish green	33	
	4 greenish yellow	11	
	5 yellow	11	
	6 orange yellow	11	
	7 orange	0	
	8 pink	0	
	9 red	0	
Aril Thickness	1 thin	67	0.637
	2 medium	33	
	3 thick	0	
Aril Texture	1 soft	56	0.995
	2 intermediate	22	
	3 firm	22	
Flesh Taste	1 slightly sweet	22	1.273
	2 sweet	44	
	3 bitter sweet	11	
	4 bland	22	
	5 sweet with bitter after-taste	0	
Flesh Aroma	1 mild	56	0.937
	2 moderate	11	
	3 strong	33	
Flesh Color	1 creamy white	44	0.965
	2 lemon yellow	44	
	3 yellow	0	
	4 yellowish orange	11	
	5 orange	0	
	6 reddish orange	0	
	7 scarlet/red	0	

Character	Category	Frequency (%)	Diversity Index (H')
Number of Carpels Per Fruit	8 pink	0	0.53
	1 three	0	
	2 four	22	
	3 five	78	
	4 six	0	
Seed Shape	1 spheroid	0	1.061
	2 ellipsoid	44	
	3 oblong	33	
	4 ovoid	0	
	5 obovoid	22	
Seed Coat Color	1 yellow-brown	56	0.687
	2 brown	44	
	3 black	0	
	4 grey orange	0	

Ten quantitative characteristics of the observation results are presented in Table 3. The coefficient of variation can be a useful tool to help describe heterogeneity (Cairns and Prendergast 2021). The coefficient of variation value can indicate the level of diversity. According to Moedjiono and Mejaya (1994), the coefficient of variation is in the range of 0-100% quartile, i.e., low ( $0\% \leq 25\%$ ), rather low ( $25\% \leq 50\%$ ), moderate ( $50\% \leq 75\%$ ), and high ( $75\% \leq 100\%$ ). The results showed that coefficient of variation value ranges from 11.47 to 43.30% with the lowest value being in the fruit diameter character (11.47%), while the highest value is in the stem height character (43.30%).

Characters that have low diversity include stem circumference, petiole length, leaf petiole width, fruit length, fruit diameter, seed weight, seed length, and seed width. Two characters, tree height and stem height, exhibit a relatively low level of diversity. Sihaloho et al. (2021) asserted that variations in durian plant morphology can be influenced by a combination of environmental factors, soil fertility, and genetic characteristics. Based on these findings, the relatively low degree of morphological diversity observed among the durian accessions is likely a reflection of the uniformity in environmental conditions across the study area. Heino (2013) stated that quantitative traits are phenotypic traits that are determined, jointly with the environment, by many genes of small effect. Compared to neutral genetic markers, quantitative traits are more sensitive to population structure and may suggest differences where neutral genetic markers fail to show any. Since the plants were located in geographically proximate areas, it is reasonable to assume that plants experienced similar climatic conditions and soil fertility profiles, thereby minimizing environmental variability as a contributing factor. Consequently, the limited morphological variation observed is more plausibly attributed to genetic differences among individual plants. This suggests that, in such homogenous environments, genetic factors play a more prominent role in shaping morphological traits. Furthermore, this underscores the importance of considering genetic diversity in conservation and cultivation strategies, particularly when environmental influences are relatively constant. Without sufficient genetic variation, efforts to improve or adapt durian

cultivars, especially in response to changing environmental conditions may be constrained.

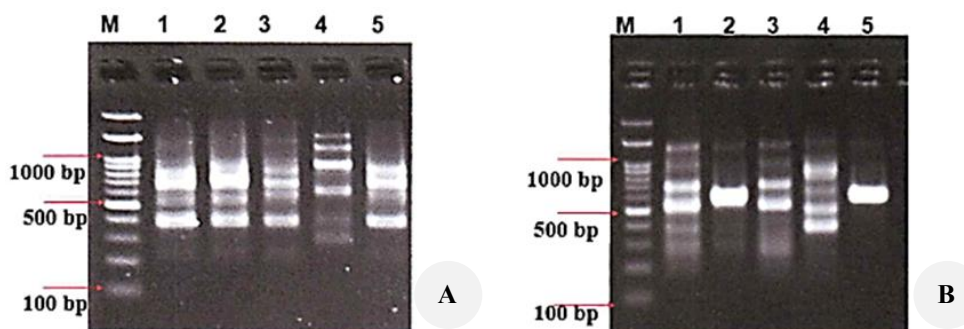
### Molecular diversity

#### *Genetic polymorphism generated by RAPD markers*

The result of a molecular analysis of five durian plants with RAPD markers is presented in Figure 4. The total number of amplified bands was 21 bands, 19 bands (90.4%) of which were polymorphic (Table 4). The OPE-20 primer had the highest percentage of polymorphisms (91.7%), and the OPP-09 primer had the lowest percentage of polymorphisms (88.9%). The reproducible polymorphic bands were detected in the 250 to 1500 bp range. Polymorphism information is necessary for studies on genetic diversity and demonstrates the efficacy of primers in finding genetic variation (Slameto 2023). The higher number of amplified and polymorphic bands generated by RAPD markers were better for discriminating the accessions (Witono et al. 2006). The values above 50% are considered highly polymorphic (Tawfik and El-Mouhamady 2019). These results indicate that the OPE-20 and OPP-09 primers are suitable for detecting genetic diversity in durian cultivars based on the number of polymorphic bands and polymorphism.

**Table 3.** Coefficient of variation of quantitative characters between the tested plants

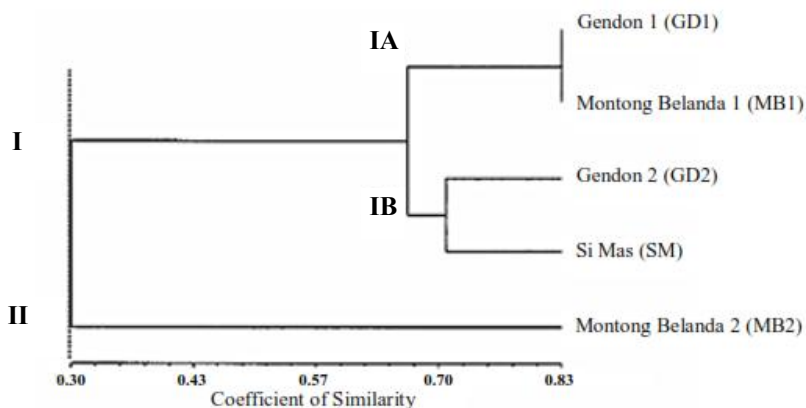
Characters	Minimal	Maximal	Mean	CV (%)
Tree height (m)	20	80	56.11	41.74
Stem height (cm)	82	438	266.44	43.30
Stem circumference (cm)	173	295	219.33	21.77
Petiole length (mm)	12.8	20.2	16.47	14.10
Petiole width (mm)	2.84	5.2	3.54	19.84
Fruit length (cm)	16	26	21.14	16.65
Fruit diameter (cm)	14.25	20	16.47	11.47
Seed weight (g)	17	32.73	24.63	22.81
Seed length (cm)	4.4	6.83	5.48	13.44
Seed width (cm)	2.47	3.67	3.24	12.71



**Figure 4.** DNA amplification of five durian accessions: A. Primer OPE-20 and B. Primer OPP-09. M: DNA ladder 100 bp, 1: GD1; 2: GD 2; 3: MB 1; 4: MB 2; and 5: SM

**Table 4.** The number of primers used for DNA amplification and the level of polymorphism

Primer	Sequence	No. of amplified bands	No. of polymorphic bands	Percentage of polymorphic bands (%)
OPE-20	5'-AACGGTGACC-3'	12	11	91.7
OPP-09	5'-GTGGTCCGCA-3'	9	8	88.9
	Total	21	19	90.4



**Figure 5.** A dendrogram among 5 durian accessions from Pantí District, Jember District, East Java, Indonesia, based on RAPD markers generated by UPGMA cluster analysis

#### Genetic similarity and cluster analysis

According to Jaccard's coefficient, the mean genetic similarity ranged from 0.25 to 1.00 (Table 5). A dendrogram generated using UPGMA clustering analysis is presented in Figure 5. The five accessions of durians are classified into two major groups with a similarity coefficient of 30%. Group 1 is made up of four different types of durians, divided into two subgroups: subgroup 1A, which includes GD1 and MB1 durians, and subgroup 1B, which includes GD2 and SM. Group 2 only included MB2 durian. The similarity coefficient values for the five accessions of durian plants range from 25 to 83%. Durian GD1 has the lowest genetic similarity (25%) to MB2 and MB1 with MB2. Low genetic similarity means that the durian plants have numerous variances. Even though the durian shares the same names as MB 1 and MB 2, it has distinct genetics. Furthermore, genetic variations can occur since the plants being evaluated are grown from seeds. The

durian plant is a cross-pollinated plant that develops seeds by acquiring traits inherited from both parents, resulting in genetic diversity (Amrullah et al. 2023). The highest genetic similarity (83%) was obtained between the GD1 and MB1 durian types. The high genetic similarity between these two types of durians shows that they are closely related. In reality, in the field, these two plants are in the same place of growth and close to each other, so they are thought to have come from the same parent. In line with Hannum and Pasaribu (2021), the high genetic similarity of plants can be caused by the same growing place, so that they may come from the same parents or closely related individuals. Similar to the research of Sari et al. (2018), accessions originating from the same area or neighboring geographical locations tend to have greater genetic similarity. Similarity among accessions within a population is probably caused by genes derived from the same ancestor (co-ancestry) in certain populations.

### Proximate and sensory properties

The results presented that the water content of durian fruit in Panti District ranges from 61.61 to 79.15%, with the maximum fruit water content found in MB2 (Table 6). Fat content ranges from 1 to 12%, where the highest is SB and the lowest is MB1. The carbohydrate flesh content ranges from 8.84 to 36.35 mg/mL. MB1 had higher amounts of carbohydrate. Sujang et al. (2024) reported the water content of local durian flesh ranged from 46.90% (*Durio graveolens*) to 69.16% (*Durio oxleyanus*). The fat content of around 3% in durian fruit is relatively high (Balitbu and IP2TP 2001). The results showed that the proximate content of durian accessions are varied. MB2 had the highest water, but had a moderate amount of fat and carbohydrates. SB had the highest fat, but had a moderate amount of water and the least carbohydrates. This could be explained by the difference in genetic materials for each cultivar that plays a pivotal role in the differences in the proximate composition of the fruits (Isa et al. 2019). Herawati et al. (2024) stated that the high water content of the flesh indicates the softer texture of the durian flesh. A high fat content indicates that the fruit flesh feels fatty, while carbohydrate content may relate to soluble solid content (SSC) and total sugar content, as well as sweet taste (Belgis et al. 2016). The water content of durian seeds obtained in this study ranges from 26.03 to 70.06%, while carbohydrate content ranges from 41.38 to 81.31 mg/mL. According to Hartati et al. (2023), durian seeds can be utilized as foodstuffs due to their content of 46.2% carbohydrate, 2.5% protein, 0.2% fat, and 51.1% water. The high carbohydrate content in durian seeds could be utilized further as flour.

The minimum, maximum, average, and coefficient of variation of proximate content in fruit and seeds are presented in Table 7. Water content in the fruit showed a low coefficient of variation of 8.54%, whereas fat content exhibited the highest variability at 90.19%. According to Effendy et al. (2018), the five characters observed had 3 levels, namely low diversity ( $0\% \leq 25\%$ ), rather low diversity ( $25\% \leq 50\%$ ), and high diversity ( $75\% \leq 100\%$ ). Characters with low diversity were obtained in the water content of the flesh and the carbohydrate content of the seeds. A rather low diversity was obtained in the water

content of the seed and the carbohydrate of the flesh. Fat content in the flesh showed high diversity.

Sensory tests were conducted on seven types of durian fruit. Variables assessed included taste, texture, aroma, and color using a 6-point hedonic scale: 1: extremely dislike, 2: dislike, 3: neutral, 4: moderately like, 5: like, and 6: extremely like, and the MDS analysis findings are shown in Figure 6. The four fruit sensory factors suggest that numerous forms of durian are close together. RKD, GD1, and SJ durians taste similarly to the other four types of durians (Figure 6.A). Durian MB1 and RKD have comparable textures, as do SJ and GD1 (Figure 6.B). The scents of durian fruit, RKD, GD1, LK, and SJ are comparable (Figure 6.C). MB1, SJ, RKD, and LK have similar fruit flesh colors, as opposed to MB2 and SB (Figure 6.D). The scatter plot shows that the panelists scored MB2 differently from other durians in the four variables tested. Accession of local durian MB2 is popular in Panti District, because it has thick flesh with yellow flesh color, has a sweet taste and a soft fruit texture. Maligan and Harisa (2021) described a distance that is relatively close in the MDS analysis results is considered almost similar by the panelists; however, a distance that is quite far from other types indicates that these types are not similar to other types. Color, attractiveness, aroma, and size are all key aspects of the fresh fruit industry (Delialioğlu et al. 2022). The findings of this study suggest that the characteristics of superior local durian in Panti District, Jember District, Indonesia, could contribute to durian breeding programs for the production of commercial cultivars.

**Table 5.** Mean of genetic similarity of five durian accessions based on RAPD markers

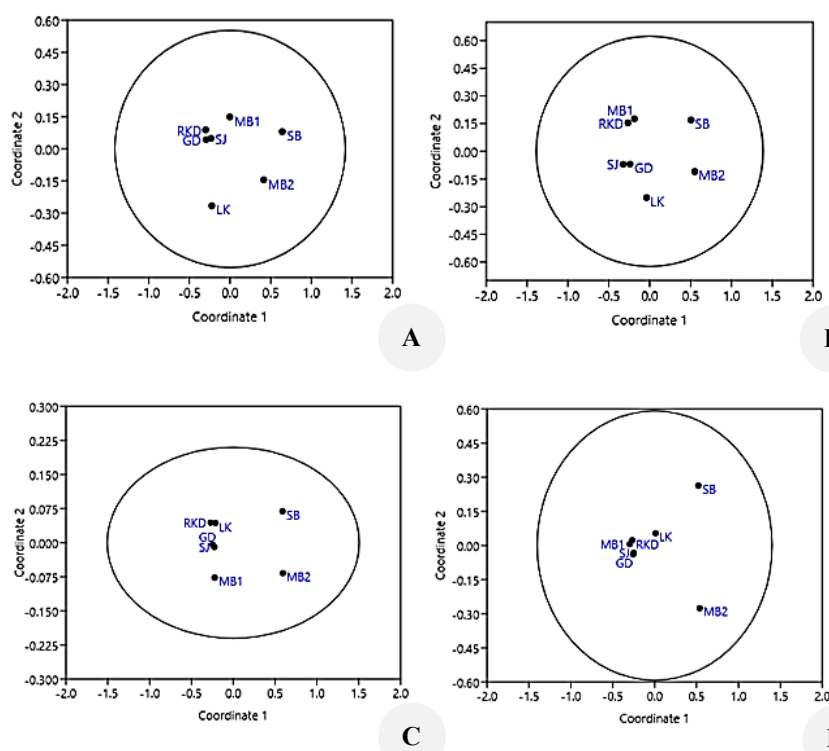
	GD1	GD2	MB1	MB2	SM
GD1	1.00				
GD2	0.75	1.00			
MB1	0.83	0.58	1.00		
MB2	0.25	0.33	0.25	1.00	
SM	0.63	0.71	0.71	0.38	1.00

**Table 6.** Results of proximate analysis of durian flesh and seed, Panti District, Jember, Indonesia

Local durian	Flesh			Seed	
	Water content (%)	Fat (%)	Carbohydrate (mg/mL)	Water content (%)	Carbohydrate (mg/mL)
SJ	67.09	5.5	11.90	49.37	81.31
MB 1	67.59	1	36.35	52.25	69.86
MB 2	79.15	3	28.92	70.06	64.32
RKD	67.38	2.5	31.40	50.56	73.19
LK	61.61	6.5	33.84	49.26	78.82
GD 1	62.66	0.5	19.12	52.80	73.70
SB	65.40	12	8.84	26.03	41.38

**Table 7.** Coefficient of variation of proximate analysis of durian seeds and fruit

Proximate		Minimal	Maximal	Mean	CV (%)
Flesh	Water content (%)	61.61	79.15	67.27	8.54
	Fat (%)	0.5	12	4.43	90.19
	Carbohydrate (mg/mL)	8.84	36.35	24.34	45.24
Seed	Water content (%)	26.03	70.06	50.05	25.68
	Carbohydrate (mg/mL)	41.38	81.31	68.94	19.40

**Figure 6.** Scatter plot Multidimensional Scaling analysis using Euclidean Distance: A. Taste, B. Texture, C. Aroma, and D. Color

In conclusion, this study demonstrates that the level and pattern of diversity vary depending on the type of trait and analytical approach employed. Morphological characteristics showed relatively limited variation, whereas molecular analysis revealed a higher degree of genetic differentiation among the durian samples. Variation was also evident in fruit composition and sensory attributes, particularly in traits related to texture and color, reflecting differences that are important for both consumer preference and breeding objectives. The integration of these datasets highlights the complex nature of durian diversity and emphasizes the value of using complementary approaches to obtain a more comprehensive assessment. The findings provide a scientific basis for developing informed conservation strategies and targeted breeding programs, supporting the sustainable development and long-term improvement of durian cultivation in the region.

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