

Morphological Study of Local Jackfruit (*Artocarpus heterophyllus* Lamk) in Sukaraja District, Seluma Regency, Bengkulu Province, Indonesia as a Source of Superior Germplasm

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Abstract – Jackfruit (*Artocarpus heterophyllus* Lamk) is a crop with great potential for cultivation due to its adaptability to diverse environmental conditions and wide distribution in home gardens. This study aimed to explore the morphological diversity of jackfruit in Sukaraja Subdistrict, Seluma Regency. A purposive sampling method was applied to 10 tree accessions collected from five villages: Bukit Peninjauan II, Cahaya Negeri, Siabun, Lubuk Sahung, and Niur. Morphological characterization was carried out qualitatively and quantitatively based on the *Descriptors of Artocarpus heterophyllus* Lamk (IPGRI, 2000), recording 35 morphological traits of stems, leaves, fruits, and seeds. Cluster analysis revealed two major groups. The first group consisted only of the Cahaya Negeri (CH) accession with 50% similarity. The second group showed 42% similarity and was divided into two subgroups: Niur (NR) and Lubuk Sahung (LS), and Siabun (SB) with Bukit Peninjauan II (BP II), which displayed 35% similarity. Several accessions, including BP II, SB, and CH1, produced fruits ranging from round to oblong, weighing 11.0-12.2 kg with soluble sugar contents of 11-15° Brix. The observed morphological variation in fruit and seed traits indicates valuable potential for jackfruit breeding programs aimed at developing superior cultivars.

Keywords – IPGRI, Exploration, Characterization, Genetic Diversity and Endemic Species.

I. INTRODUCTION

Jackfruit (*Artocarpus heterophyllus* Lamk) is a plant native to India and widely cultivated throughout Southeast Asia. It is a tropical species capable of bearing fruit year-round. In Indonesia, jackfruit trees are widely distributed across almost all regions, commonly planted in home gardens and integrated with other perennial crops. Nearly all parts of the jackfruit plant, including the seeds, fruit, stem, leaves, and even the rind can be utilized (Siregar, 2022).

According to Shedje et al., (2022), jackfruit contains carbohydrates, fiber, protein, vitamins, and essential minerals that are beneficial to human health. In 100 g of ripe jackfruit pulp, there are approximately 95-157 calories, 16-25 g of carbohydrates, 1.2-3 g of protein, 0.1-1.1 g of fat, and 1-3 g of dietary fiber. It is also a good source of vitamin C (13.7-22.6 mg), vitamin A, and B-complex vitamins (such as thiamine, riboflavin, niacin, and vitamin B6). In addition, jackfruit contains essential minerals including potassium, magnesium, calcium, phosphorus, and iron. The presence of antioxidants such as carotenoids and flavonoids plays a crucial role in neutralizing free radicals and supporting the immune system (Sumitra, 2022).

Jackfruit is a highly promising crop for further development. It can be utilized for various purposes, including food, construction materials, reforestation, and livestock feed (Mandasari et al., 2014). The potential of jackfruit is also evident from its ability to adapt to various types of soil and tropical climates, and its production is relatively stable throughout the year. With high nutritional content and wide health benefits, jackfruit has strong

potential to be developed as a priority commodity to support food security and improve farmers' livelihoods in tropical countries (Nantongo et al., 2022).

Genetic diversity in jackfruit is crucial for plant breeding efforts and the conservation of genetic resources (germplasm). Jackfruit germplasm is an important genetic resource representing the morphological and genetic diversity found in tropical Asia, particularly in Indonesia (Sulassih et al., 2013). According to Ito (2013), the diversity of jackfruit in Indonesia is reflected in the variation of fruit shape and size, flesh color, and taste across different regions.

Despite its potential, studies on jackfruit remain limited. Morphological characterization at the early stages is essential for plant breeding programs aimed at developing superior cultivars. Observations of morphological traits, including phenotypic characteristics such as stem, leaf, flower, fruit, and seed morphology, provide fundamental insights into the genetic variation within a plant population (Nakayama, 2023). Morphological analysis plays a critical role in identifying desirable traits—such as fruit size, flesh thickness, and pest resistance—which serve as key selection criteria in breeding programs. This morphological diversity reflects underlying genetic differences, which are the primary source for selecting superior genotypes. Therefore, this study aimed to study the morphological characteristics of local jackfruit in Sukaraja District, Seluma Regency.

II. MATERIALS AND METHODS

The research was conducted in Sukaraja District, Seluma Regency, Bengkulu Province from July to October 2024. The research involved several stages, including field surveys, sample site selection, fruit growth monitoring, sample collection, germination testing, seedling preparation, planting media preparation, and transplanting of seedling. Plant growth analysis was carried out in the greenhouse of the Agronomy Laboratory, Faculty of Agriculture, University of Bengkulu, Indonesia from July to September 2024.

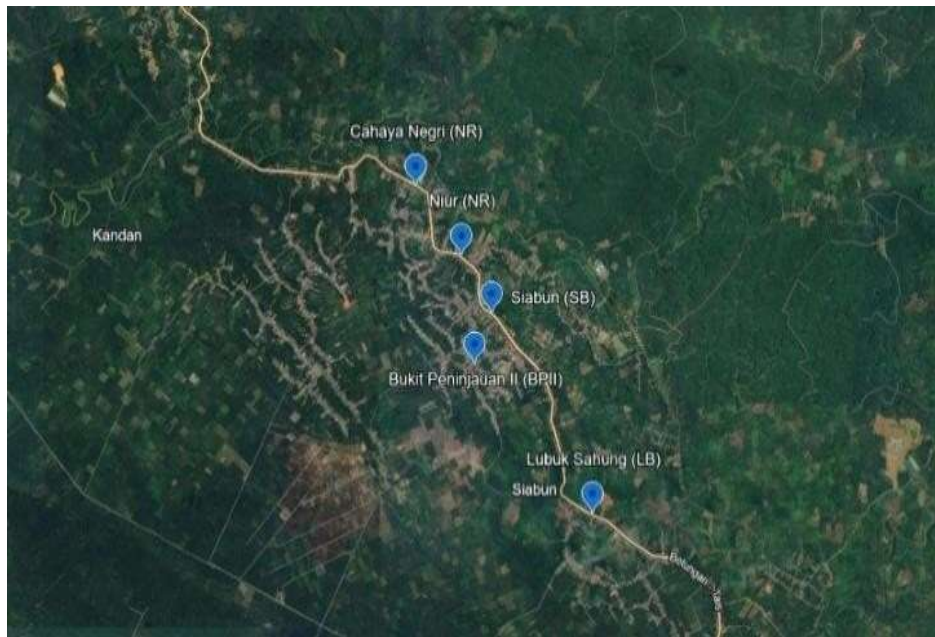


Fig. 1. Geographic map of jackfruit research locations.

The equipment used in this study included a measuring tape, Global Positioning System (GPS), bench scale, camera, penetrometer, refractometer, standard color chart (Munsell), caliper, digital scale, ruler, knife, and

plastic bucket. A total of 10 jackfruit trees located in five villages in Sukaraja District, Seluma Regency namely Siabun, Cahaya Negeri, Bukit Peninjauan II, Niur, and Lubuk Sahung were used as research subjects. The village codes used to indicate the origin of the jackfruit accessions, identified as follows: Siabun (SB), Bukit Peninjauan II (BP II), Cahaya Negeri (CH), Lubuk Sahung (LB), and Niur (NR).

This study employed direct field data collection through morphological observations of the jackfruit tree, leaves, stem, and fruit. Samples were selected using purposive sampling and analyzed using the PBSAT program. The jackfruit trees observed were at least 10 years old, in healthy condition, and had already produced flowers and fruits.

Morphological characterization of jackfruit plants was carried out based on the guidelines of the International Plant Genetic Resources Institute (IPGRI, 2000). A total of 34 morphological traits were recorded. 13 qualitative traits included canopy shape, branch growth direction, leaf blade shape, leaf apex shape, leaf color, petiole shape, type of peduncle attachment to the fruit, fruit shape, flesh shape, seed shape, fruit skin color, flesh color, and seed coat color. The remaining 21 traits were quantitative, including stem circumference (cm), leaf blade length (cm), leaf blade width (cm), fruit length (cm), fruit width (cm), width around the whole fruit (cm), fruit weight (kg), fruit firmness (kgf/cm²), fruit flesh weight (g), seed weight (g), non-edible rachis weight (kg), total non-edible rachis weight (kg), perianth length (cm), thickness of fruit flesh (mm), perianth width (cm), length of fruit stalk (cm), total number of seeds, number of seeds per kg, fruit skin thickness (mm), sugar level (°Brix), and seed hardness (mld).

III. RESULTS AND DISCUSSION

Variations in canopy or crown shape were observed among jackfruit trees, including pyramidal in Bukit Peninjauan II, broad pyramidal in Siabun, elliptical in Niur, and irregular in Lubuk Sahung. According to Baswajit (2019), a wide range of morphological variation was found among jackfruit accessions. Variations in crown shape such as irregular, elliptical, oblong, and spherical were observed. (Figure 2).

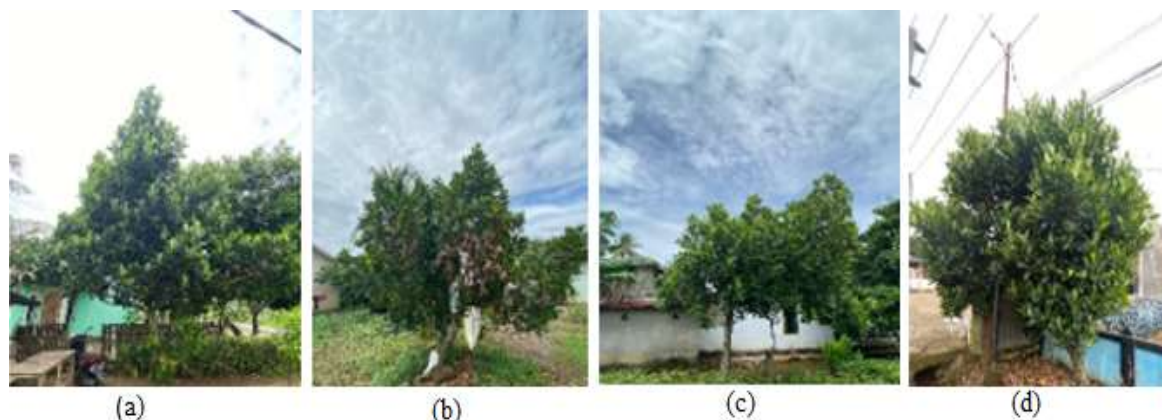


Fig. 2. The crown shape: (A) Bukit Peninjauan II (pyramidal); (B) Siabun (broad pyramidal); (C) Lubuk Sahung (irregular); (D) Niur (elliptical).

Three types of branching patterns were identified irregular, horizontal, and opposite. Two accessions exhibited an irregular branching pattern, namely Niur and Lubuk Sahung. Two accessions showed a horizontal branching pattern, namely Bukit Peninjauan II and Cahaya Negeri. One accession displayed an opposite branching pattern, namely Siabun (Figure 3).

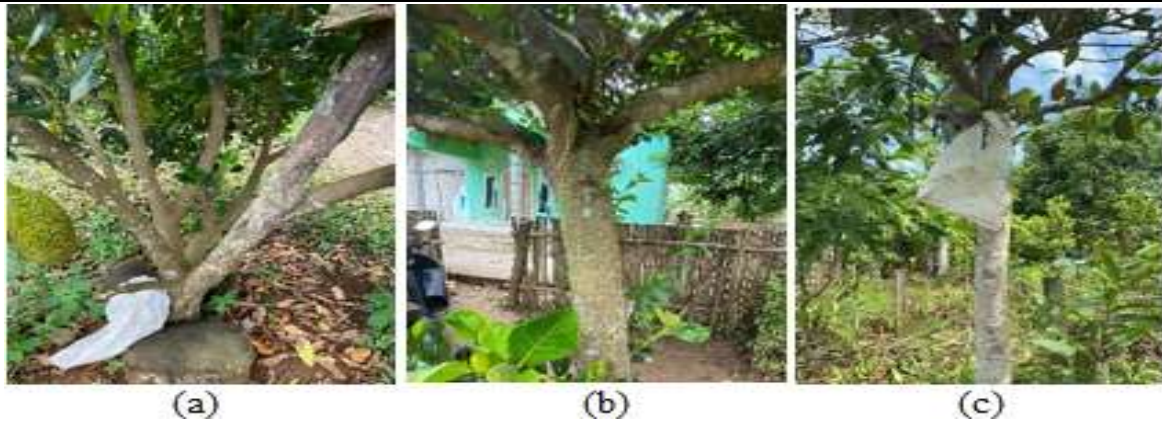


Fig. 3. Types of branching pattern: (A) Niur Village (irregular); (B) Cahaya Negeri Village (horizontal); (C) Siabun Village (opposite).

Jackfruit trees possess dense branching that aids in maintaining soil moisture and promoting air circulation within the canopy. However, regular pruning is essential to shape the canopy, prevent disease, and stimulate new growth (Rahmawati *et al.*, 2022).

The leaf shape of jackfruit varied from round to green with pointed tips. There were three types of leaf blade shapes observed: elliptic, broadly elliptic, and narrowly elliptic. Two accessions with elliptic leaves were found in Niur Village and Siabun Village. One accession with a broadly elliptic shape was found in Bukit Peninjauan II Village, and two accessions with narrowly elliptic leaves were identified in Cahaya Negeri Village and Lubuk Sahung Village (Figure 4). According to Rida *et al.*, (2021), the leaf blade is generally oblong (elongated oval) to obovate, with lengths ranging from 3.5 to 25 cm and widths from 5 to 12 cm, depending on the variety and leaf age.

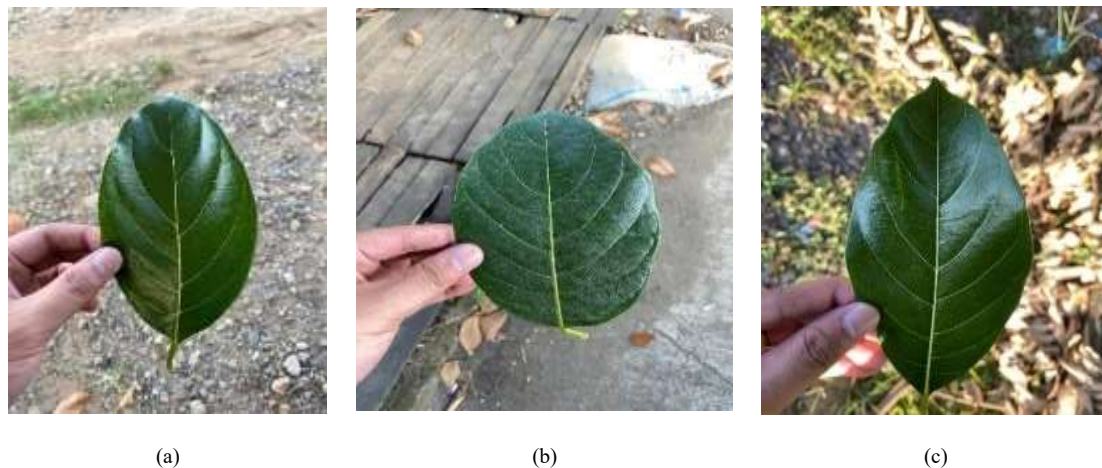


Fig. 4. Leaf shape: (A) Niur (elliptic); (B) Bukit Peninjauan II (broadly elliptic); (C). Cahaya Negeri (narrowly elliptic).

Jackfruit exhibited variability in its fruit characteristics, with the number of fruits formed primarily influenced by the thickness of the rind and pulp. According to Anggriana *et al.*, (2017), seeds accounted for approximately 8% to 15% of the total fruit weight. In this study, around 40% to 50% of the total fruit weight consisted of the rind and rachis (Figure 5). The perianth played a crucial role in supporting and protecting the pulp during the fruit development process. The edible pulp was formed from layers of white-colored perianth that envelop the entire flesh portion of the fruit (Nisrina, 2023).

The rind thickness of jackfruit varied among accessions, on the accession of the village of Cahaya Negeri reaching up to 1.8 mm. According to Jagadeesh *et al.*, (2007), jackfruit exhibited variation in pulp thickness,

which is influenced by both genetic factors and the environmental conditions in which the tree grows. One of the superior cultivars was the Siddu Jackfruit from Karnataka, which had an average pulp thickness of approximately 8.5 mm. Additionally, the cross-sectional view of the jackfruit showed a consistent density of the false fruit pulp within the fruit.



Fig. 5. Fruit peel thickness: (A) Siabun; (B) Bukit Peninjaun II; (C) Cahaya Negeri.

Jackfruit can weighed up to 12.2 kg, with a fruit firmness of 12.1 kgf/cm², a sugar content of 15 °Brix, and pulp color ranged from light yellow to deep yellow. According to Singh (2019), jackfruit can reached a weight of up to 35 kg, with thick pulp ranging in color from yellow to orange and a natural sugar content of approximately 19.08 °Brix, influenced by variety, environmental conditions, and cultivation techniques. Meanwhile, Dhakar et al., (2020), reported jackfruit weighing 44.63 kg, with a length of 59.54 cm and a sugar content of 15.94 °Brix.

There are 3 forms of jackfruit, namely spheroid in the Siabun and Cahaya Negeri village accessions, ellipsoid in the Bukit Peninjauan II village accession. A study Vazhacharickal *et al.*, (2017), identified various fruit shapes, such as round, elongated, and oblong. The skin color of the jackfruit accessions examined ranged from green in the unripe stage to yellow or yellowish-brown when ripe, reflecting differences in ripening stages and genetic variation among genotypes (Figure 6).

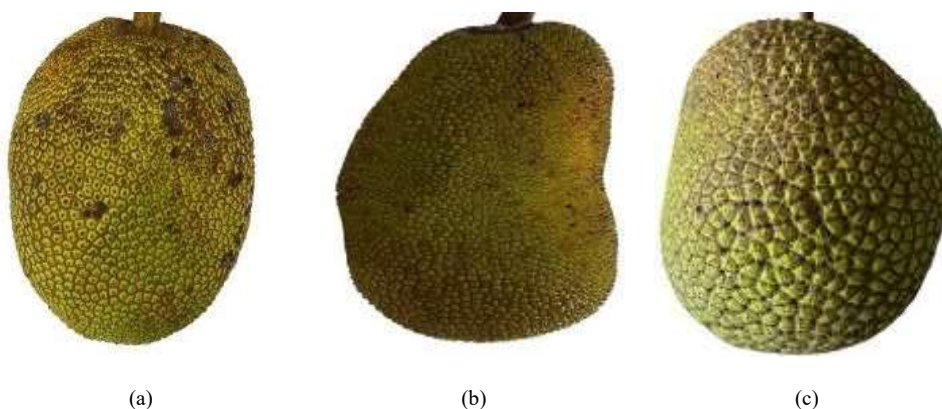


Fig. 6. Jackfruit shape: (A) Siabun (spheroid); (B) Bukit Peninjauan II (ellipsoid), (C) Cahaya Negeri (spheroid).

The flesh color of jackfruit accessions observed in this study ranged from light yellow to dark yellow, consistent with the findings reported by Nugraha *et al.*, (2022), in Kalimantan. The fruit flesh shapes in the Siabun, Bukit Peninjauan, and Cahaya Negeri accessions were identified as twisted, cordate, and twisted, respectively (Figure7). Seed shapes varied among accessions, with ellipsoid observed in Siabun, oblong in Bukit

Peninjau II, and irregular in Cahaya Negeri (Figure 8). The seed coat color also varied, including pale white, dull brown, and cream.

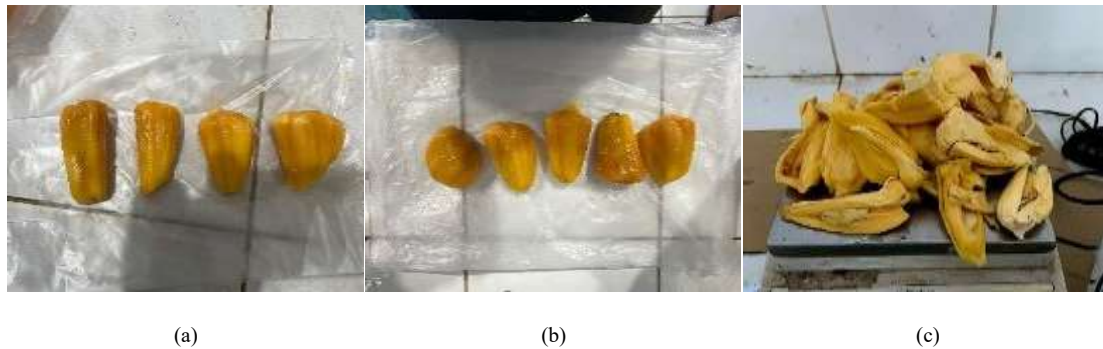


Fig. 7. Friut flesh shape: (A) Siabun (twisted); (B) Bukit Peninjauan II (cordate); (C) Cahaya Negeri (twisted).

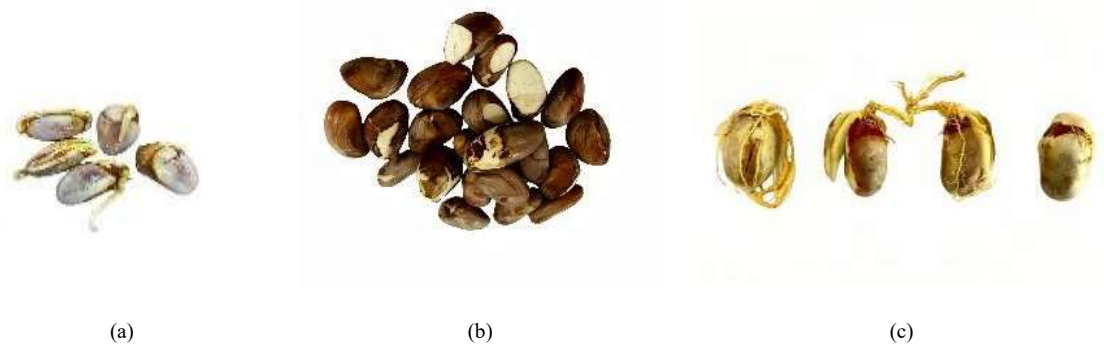


Fig. 8. Jackfruit seed shape: (A) Siabun (ellipsoid); (B) Bukit Peninjauan II (oblong); (C) Cahaya Negeri (irregular).

Fruit characteristics such as size, color, pulp thickness, and texture are key indicators in determining varieties with high economic value (Dey, 2024). Morphological traits such as pulp thickness and seed size possess high heritability, making them valuable criteria in the selection of superior plant genotypes (Wangchu *et al.*, 2013).

Figure 1 illustrated the dendrogram of the genetic relationships among jackfruit genotypes based on crown and leaf morphological characteristics. This dendrogram was resulted from the value of cophenetic distance. The PBSTAT program was employed to analyze the differences of morphological characters of jackfruit. The analysis revealed two main groups. Group 1 consisted solely of the Cahaya Negeri (CH) accession with a 50% similarity level. Group 2 exhibited a similarity level of 42% and was further divided into two subgroups: Subgroup 1 comprised of Niur (NR) and Lubuk Sahung (LB). Meanwhile, Subgroup 2 included Siabun (SB) and Bukit Peninjauan II (BP II). These two subgroups demonstrated a similarity level of 35%. Moreover, Table 1, which presents the morphological analysis of jackfruit trees in Sukaraja District, also indicated variability across the 35 observed characters. For example, in crown shape, Group 1 was predominantly characterized by the elliptical type, while Group 2 exhibited greater variation, including pyramidal, irregular, and elliptical forms.

Table 1. Characteristics of jackfruit plants in Sukaraja District, Seluma based on morphological and physicochemical characteristics.

Characteristics	Group 1	Group 2
Tree canopy shape	Elliptical	Pyramidal, Irregular, Elliptical
The direction of tree branch growth	Opposite	Irregular, Horizontal
Leaf shape	Narrowly elliptic	Elliptic, Broadly Elliptic

Characteristics	Group 1	Group 2
Leaf blade tip shape	Acuminate	Acuminate, obtuse
Leaf color	Green	Green
Petiole shape	Rounded	Rounded, Cunaete
Fruit shape	Spheroid	Ellipsoid, Spheroid
Fruit stalk	Inflated	Depressed, Flattened
Form the flesh of the fruit	Twisted	Twisted, Cordate
Seed form	Irregular	Elipsoid, Oblong
Fruit skin color	Greenish yellow	Greenish yellow
Fruit flesh color	Light yellow	Dark yellow
Seed coat color	Cream	Pale white, Dull brown
Stem circumference (cm)	76	72-81
Leaf length (cm)	12.8	10-15
Leaf width (cm)	8.07	8-10
Fruit length (cm)	38	38-46
Fruit width (cm)	25	15-25
Width around the fruit (cm)	86.5	75-85
Fruit weight (kg)	11	11-12.2
Fruit firmness (kgf/cm ²)	6.46	08-12.1
Fruit flesh weight (g)	406.97	406-562.05
Seed weight (g)	158.69	150-170
Non-edible rachis weight (g)	803.16	422-515
Total non-edible rachis weight (kg)	5.2	7-8
Perianth length (cm)	26	20-37
Fruit skin thickness (mm)	1.36	1.5-1.8
Thickness of fruit flesh (mm)	0.4	0.4-0.5
Perianth width (cm)	8	6-7.6
Sugar level (°brix)	11	11-15
Seed hardness (mld)	0.8	0.8 - 17
Length of fruit stalk (cm)	13	8-13
Total number of seeds	78	67-83
Number of seeds per kg	18	15-21

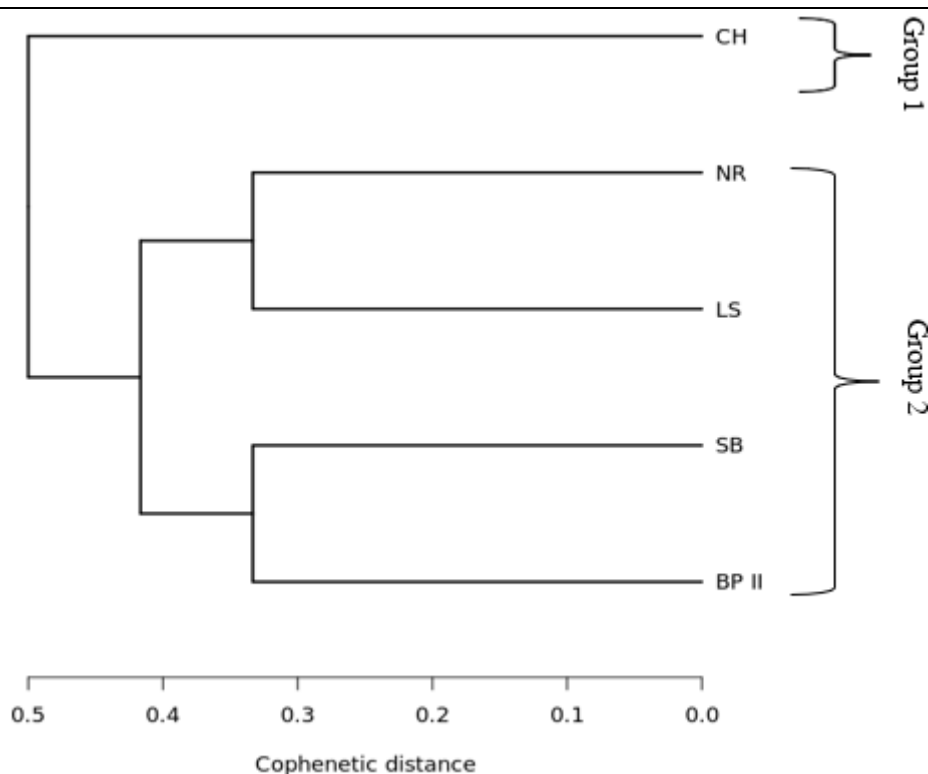


Fig. 9. Dendrogram of Jackfruit in Sukaraja District, Bengkulu Province Based on Crown and Leaf Morphological Characters.

IV. CONCLUSIONS

There is significant diversity among jackfruit in Sukaraja District, both qualitatively and quantitatively, particularly in crown, leaf, and fruit traits. Cluster analysis and the resulting dendrogram of 10 accessions revealed the formation of two main groups. Group 1 consisted solely of the Cahaya Negeri (CH) accession, which exhibited a 50% similarity level, indicating a clear morphological distinction compared to the other accessions. In contrast, Group 2 showed a similarity level of 42% and was further divided into two subgroups: Subgroup 1, comprising Niur (NR) and Lubuk Sahung (LB), and Subgroup 2, consisting of Siabun (SB) and Bukit Peninjauan II (BP II). Both subgroups demonstrated a similarity level of 35%. Overall, the grouping results highlighted substantial morphological variation, with Cahaya Negeri (CH) identified as the most distinct accession, while the remaining accessions tended to cluster based on similarities in crown and leaf characters. This diversity holds potential for the identification of superior varieties and supports breeding programs aimed at improving the quality and adaptability of jackfruit to various environments.

ACKNOWLEDGEMENTS

This research was funded by the faculty of Agriculture University of Bengkulu, in 2024 under grant number 2987/UN30.11/PT/2024.

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