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MORPHOLOGICAL STUDY OF LOCAL JACKFRUIT (*Artocarpus heterophyllus* Lamk) IN SUNGAI SERUT DISTRICT, BENGKULU CITY, INDONESIA

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ABSTRACT

Jackfruit (*Artocarpus heterophyllus*) is a tropical fruit plant with high economic value and is widely cultivated in Indonesia, including in Bengkulu. Bengkulu Province produces jackfruit from local varieties throughout the year. This study aimed to study the genetic diversity of local jackfruit in Sungai Serut district, Bengkulu City, based on morphological characters. The research was conducted from August to November 2024 on ten jackfruit trees from five villages in Sungai Serut district. The method used was field observation and purposive sampling technique. Morphological identification was carried out using qualitative and quantitative data, referring to the description of jackfruit published by the *International Plant Genetic Resources Institute* in 2000. Thirty- two (32) morphological characters of jackfruit trees in Sukamerindu 1, Sukamerindu 2, Tanjung Agung 1, Tanjung Agung 2, Semarang 1, Semarang 2, Tanjung Jaya 1, Tanjung Jaya 2, Surabaya 1, and Surabaya 2 were identified. The results indicated significant morphological variability among the accessions, especially in fruit shape (cylindrical, round, and oval) and leaf shape (oval, oblong, and elliptic). Fruit weight ranged from 4 kg to 9 kg. Fruit soluble solids concentration ranged from 10 to 20 % Brix. In addition to stem and seed differences, these findings demonstrated considerable morphological differences in jackfruit that might be used as material for plant breeding to find superior accessions.

Keywords: *Artocarpus heterophyllus*, IPGRI, Exploration, Identification, Characterization

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INTRODUCTION

Jackfruit (*Artocarpus heterophyllus* Lamk) originated in India and has spread to Indonesia. About 30 cultivars have been identified, 20 of which are located in Java. The large jackfruit fruit has a sweet taste and distinctive aroma and is rich in vitamins, minerals, and calories. In addition to its fruit, ripe jackfruit seeds contain essential minerals and vitamins (Widarti *et al*., 2013). Jackfruit belongs to the *Moraceae* family, order *Urticales*, and subclass *Dicotyledoneae* (Handayani, 2016). Every 100 g of jackfruit contains 10 g of carbohydrates, 0.9 g of protein, 0.8 g of fat, and 29 g of amylose (Hettiaratchi *et al*., 2011). Jackfruit flowers contain vitamin C and antioxidants benefiting for fighting free radicals (Prakash *et al*., 2009). Jackfruit leaves have antioxidant properties that are beneficial for treating hyperglycemia and hyperlipidemia (Omar *et al*., 2011).

Bengkulu is one of the jackfruit-producing regions in Indonesia, and it has a diversity of jackfruit cultivars. Each jackfruit cultivar has different characteristics. Characterization is a prominent first step to identify variations in plants' vegetative and generative growth, which can help describe their traits (Simanjuntak *et al*., 2022). Characterization of genetic resources from existing germplasm can enrich diversity, especially in developing superior varieties (Afrizon, 2015). Plant characterization contributes to preserving genetic resources (Ahimsa *et al*., 2018) and to finding superior traits of a plant genotype (Chandrashekar *et al*., 2018).

Preserving local genetic resources also plays a role in preventing plant genetic erosion and the extinction of valuable genetic material. Proper conservation and development can increase the genetic diversity of local jackfruit (Safitri and Palupi, 2017). This study was aimed to study the morphological characters of jackfruit plants in Sungai Serut district, Bengkulu City, Indonesia.

Breeding programs need to develop for specific crop such as jackfruit, targeting development of varieties that are tolerance to climate change (Jarvis et al., 2010).

METHODOLOGY

The research was conducted from August to November 2024 in five urban villages in Sungai Serut Subdistrict, Bengkulu City, namely Sukamerindu, Tanjung Agung, Semarang, Tanjung Jaya, and Surabaya Urban, Bengkulu City (Figure 1).

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Figure 1: Graphical map of jackfruit locations

The study was conducted on 10 jackfruit trees. The criteria for the trees studied were those aged 8-10 years, healthy, and fruited. The morphological characters studied were stems, leaves, fruit, and seeds. Tools used in this study were stationary, Global Positioning System (GPS), knife, ruler, digital camera, meter, vernier, digital scale, label paper, refractometer, penetrometer, potentiometer, and Munsell color chart.

This study used the observation method. Sampling was done purposively. Samples were selected on healthy, flowering, and fruiting plants and had a complete morphological structure. The identified morphological characters included 32 characters, namely 14 qualitative characters and

18 quantitative characters. Genetic codes were determined based on accession origin and sequence of findings and identified with the following codes: Sukamerindu 1 (SKM1), Sukamerindu 2 (SKM2), Tanjung Agung 1 (TA1), Tanjung Agung 2 (TA2), Semarang 1 (SMR1), Semarang 2 (SMR2), Tanjung Jaya 1 (TJ1), Tanjung Jaya 2 (TJ2), Surabaya 1 (SRB1), and Surabaya 2 (SRB2).

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The method used for the morphological characterization of jackfruit was based on guidelines established by the International Plant Genetic Resources Institute (IPGRI) in 2000.

Qualitative characters observed were crown shape, branch growth direction, leaf blade shape, leaf shoot shape, leaf base shape, leaf color, fruit shape, stem attachment to the fruit, fruit flesh shape, seed shape, fruit skin color, fruit flesh color, seed coat color, and dami (non-edible small size of fruit flesh) color of the fruit. At the same time, quantitative characters included stem circumference (cm), leaf blade length (cm), leaf blade width (cm), whole fruit length (cm), whole fruit width (cm), whole fruit circumference (cm), whole fruit weight (kg), fruit flesh thickness (mm), fruit stalk length (cm), fruit hardness (kgf), fruit flesh weight (g), seed weight (g), straw weight (g), straw length (cm), straw width (cm), number of seeds (grains), total sugar content (% Brix) and fruit skin thickness (mm).

Field observation data were analyzed using two approaches.

1. Component Analysis

This analysis was carried out on qualitative data and quantitative data using the average value, standard deviation, maximum value and minimum value;

2. Phylogenetic Relationship Analysis

This analysis was conducted to observe the relationships based on similarities and differences in characteristics, such as morphology or genetic character data.

Data were recorded in tabular from for each accessions and analyzed descriptively to assess morphological variation.

RESULTS

The study demonstraded morphological variation among the jackfruit accessions. Leaf shape: majority of accessions had oval-shaped leaves (53.3%), followed by oblong (33.3%) and elliptic (13.3%); Leaf base shape: tapered base dominated (60%), while rounded base was less frequent (40%); Leaf margin: flat margins were most common (66.7%), and wavy margins occurred in 33.3% of accessions; Leaf tif: pointed tip was predominant (73.3%), with only 26.7% and oval (40%); Rind color: yellowish green was the most common rind color (40%), followed by light green (33.3%) and dark green (26.7%). Jackfruit accessions showed differences in crown shape, branch growth direction, leaf blade shape, leaf tip shape, leaf base shape, leaf color, stem circumference, and leaf blade length and width (Table 2).

Based on the cluster analysis results of jackfruit morphological traits of crown and leaves, there were two groups. Group 1 consisted of 4 accessions (SKM1, SKM2, TJ1 and TJ2) and group 2

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included 6 accessions (TA1, TA2, SMR1, SMR2, SRB1, and SRB2) (Figure 2). The smaller the Cophenetic distance value, the higher the similarity between accessions. Conversely, the greater the Cophenetic distance value, the lower the level of similarity. Accessions SKM2, TJ1, TA1, TA2, SMR1, SMR2, SRB1, and SRB2 had a Cophenetic value of 0.3. These results indicated that the eight jackfruit accessions were similar. Meanwhile, SKM1 accession had a Cophenetic distance value of 0.42, and TJ2, with a Cophenetic distance value of 0.59, had a low similarity value.

Table 1: Summary table of statistical analysis results (Mean, standard deviation, maximum value, minimum value)

Quantitative parameters	Average	Standard deviation	Maxsimum	Minimum
Stem circumference (cm)	47	10.01	64	24
Leaf blade length (cm)	15.6	1.33	17.5	13.7
Leaf width (cm)	7.99	0.56	9	7
Fruit length (cm)	39.66	9.50	49	30
Fruit width (cm)	18	5.29	24	14
Fruit circumference (cm)	61.66	4.72	67	58
Fruit weight (kg)	6.73	2.53	9	4
Fruit hardness (kgf)	12.53	1.25	13.4	11.1
Fruit flesh weight (gr)	442.80	182.41	627.67	262.94
Seed weight (gr)	319	288.26	645.79	100.78
Sugar content (brix)	15.33	5.03	20	10
Fruit stalk length (cm)	8.66	2.30	10	6
Total number of seeds (grains)	102.66	88.73	205	47
Number of seeds per g (butir)	16	13.22	31	6
Perianth weight (gr)	259,13	89,96	359,5	185,74
Perianth length (cm)	30	2	32	28
Perianth width (cm)	1	0	1	1
Thickness of fruit skin (cm)	2,33	0,57	3	2
Thickness of fruit flesh (cm)	3,77	2,18	5,5	1,31

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The results of statistical analysis on quantitative parameters revealed considerable variation in several plant morphological traits, reflecting phenotypic diversity among the observed samples. This diversity indicates the presence of genetic potential that can be utilized in plant breeding programs to develop superior varieties with desirable morphological characteristics and fruit quality (Table 1).

Table 2: Characteristics of jackfruit plants in Sungai Serut District, Bengkulu City

Characteristics	Group I	Group II
Crown shape	pyramidal -irregular	pyramidal- broad-irregular pyramidal
Branching pattern direction	opposite-horizontal	opposite-horizontal
Leaf blade shape	oblong-elliptical	obovate-narrowly-elliptic
Shape of leaf shoots	acute-acuminate	acuminate-retuse-acute
Basic leaf shape	oblique-cuneate	oblique-rounded
Leaf color	dark green	green
Trunk circumference (cm)	24-64	45-52
Leaf blade length (cm)	14-17.5	3.7-16.2
Leaf blade width (cm)	7.9-8.3	7-9
Fruit shape	spheroid-ellipsoid	clavate
Stem attachment to fruit	flattened-inflated	flattened
Fruit flesh shape	spheroid-twisted	irregular
Seed shape	spheroid-ellipsoid	oblong
Fruit skin color	greenish yellow	greenish yellow
Seed coat color	dull brown-brown	creams
Fruit length (cm)	30-40	49
Fruit width (cm)	14-24	16
Fruit diameter (cm)	60-67	58
Whole fruit weight (kg)	4-9	7.2
Fruit hardness (kgf)	11.1-13.4	13.1
Seed weight (g)	64.579-100.78	210.44
Straw weight (kg)	185.74-232.15	359.50
Fruit skin thickness (mm)	2-3	2
Fruit flesh thickness (mm)	1.31-4.5	5.5

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Dami width (cm)	1	1
Sugar content (% Brix)	10-20	16
Fruit stalk length (cm)	6-10	10
Number of seeds	47-56	205

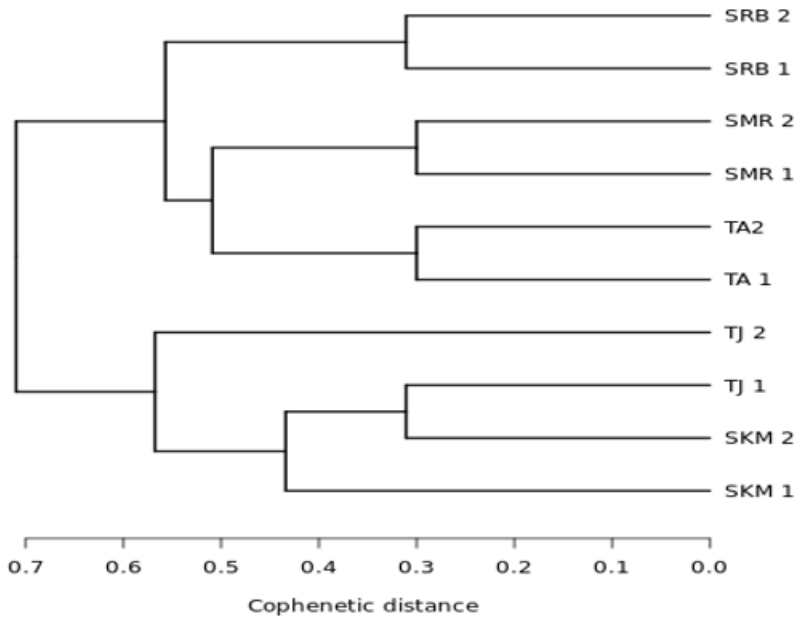

Figure 2: Similarity dendrogram of jackfruit of Sungai Serut District, Bengkulu City (SRB2, SRB1, SMR2, SMR1, TA2, TA1, TJ2, TJ1, SKM2, SKM1)

Three crown shapes were found in the 32 morphological characters studied: pyramidal, broad pyramidal, and irregular (Figure 3). There were three fruit shapes: oval, round oval, and club (Figure 4).

DISCUSSION

Jackfruit had morphological variations influenced by genetic and environmental factors. Differences in fruit size, pulp shape, and sugar content reflected high adaptability to local conditions. The morphological characters observed, such as skin thickness, pulp color, and seed shape, are in line with previous research (Rizqi, 2022). This diversity was most likely influenced by factors such as introduction, hybridization, mutation, and possible transgenic modification (Sampath *et al*., 2019). This morphological variation contributes to improved plant adaptation and resilience, thus supporting the development of improved germplasm for cultivation and commercialization.

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The dendrogram results showed that jackfruit plants in Sungai Serut district had a diversity of morphological characters. Each plant accession showed different morphological characters, such as crown shape, branch growth direction, leaf blade shape, leaf tip shape, leaf base shape, leaf color, stem circumference, and leaf blade length and width. The dendrogram diagram might be a reference for selecting desired plant characters to improve plant traits (Palupi and Daryono, 2021).

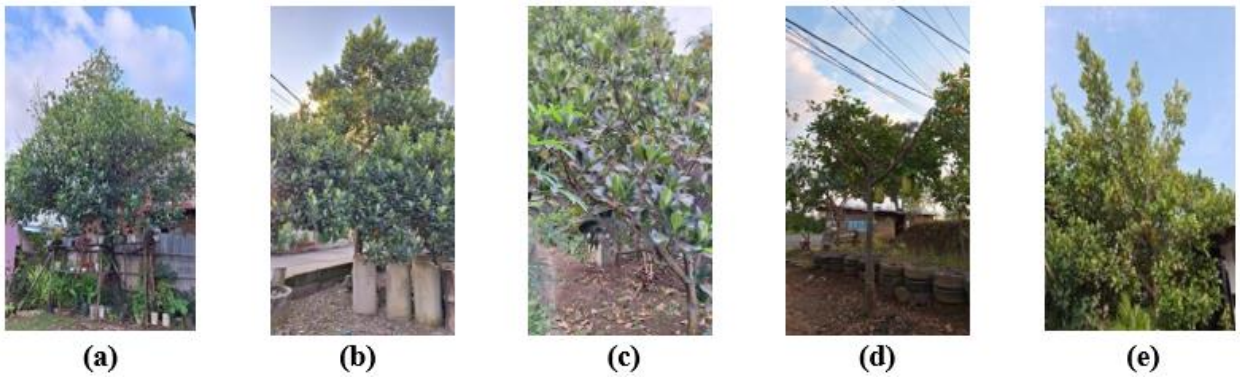

Figure 3: Jackfruit tree crown shape: (a) pyramidal (TA2), (b) broad pyramidal (SMR2), (c) pyramidal (SKM1), (d) broad pyramidal (SRB1), and (e) ireegular (TJ2)

Jackfruit leaves had elliptical, narrow oval, and ovate shapes, with green color and sharply pointed tips (Table 1). Variations in jackfruit leaf shape might result from different microclimates (Chandrashekar et al., 2018). The thickness of jackfruit pulp and skin varied. This difference in thickness might be due to cross-pollination of plant traits and genotypic characteristics of jackfruit plants (Wangchu *et al*., 2013).

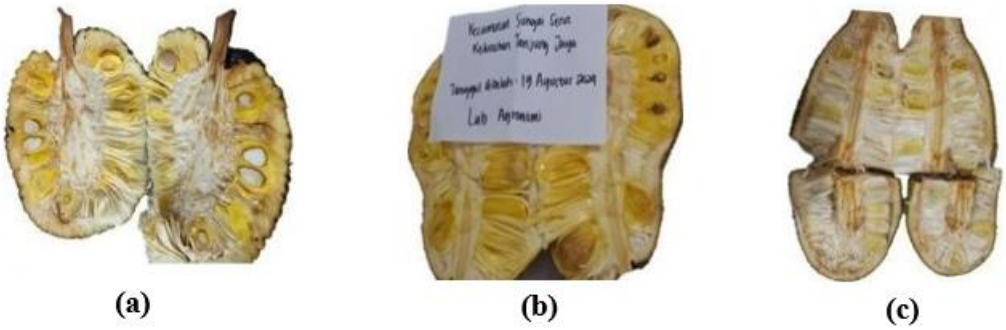

Figure 4: Cross-section of jackfruit: (a) oval (SKM1), (b) round oval (TJ2), (c) club (SRB1)

Jackfruit grown in Sungai Serut district had a maximum fruit weight of 9 kg, with a fruit hardness level of 13.4 kgf, and sugar content of 10-20 % Brix, yellow to dark yellow fruit flesh color. The color of the fruit skin showed uniformity in all accessions, with greenish yellow color. Variations in fruit weight, length, and width in different jackfruit genotypes might be caused by the genetic

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composition of each genotype. In addition, fruit size was influenced by the supply of plant nutrients (Kumar *et al*., 2022).

Whole jackfruit fruits varied in shape, including spheroid, ellipsoid, and clavate shapes (Figure 6). Fruit shape was a key characteristic affecting the selection of consumable portions, with uniform and intact shapes being preferred for marketing purposes (Dileep *et al*., 2023). Variation in fruit shape was the result of interactions between genetic traits and pollination processes. Different types of pollination resulted in irregularly shaped fruits, while uniform pollination resulted in symmetrically shaped fruits as seeds were evenly distributed (Dey and Baruah, 2019).

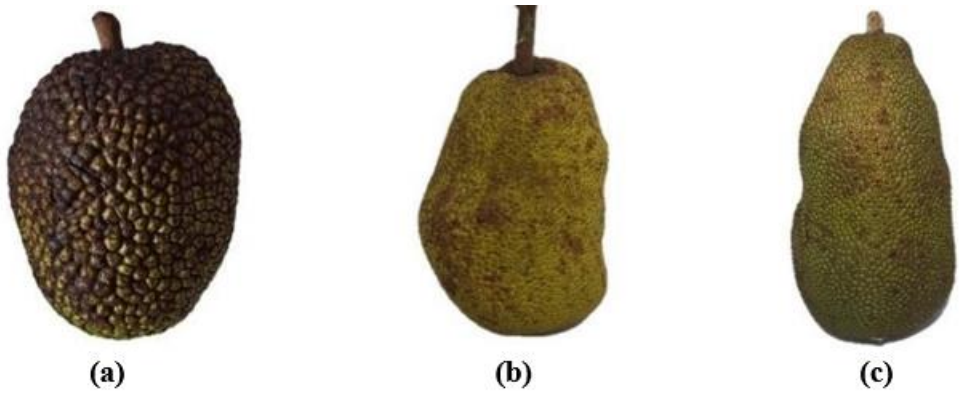

Figure 5: Variations fruit shape: (a) spheroid (SKM1), (b) ellipsoid (TJ2), (c) clavate (SRB1)

The flesh of jackfruit accessions had a consistent color, ranging from yellow, light yellow and dark yellow. This variation in fruit skin color was caused by the accumulation of one or more combinations of pigments, including chlorophyll, anthocyanins, and carotenoids in the fruit skin (Akter and Rahman, 2017). The shape of jackfruit flesh in accessions Sukamerindu 1, Tanjung Jaya 2, and Surabaya 1 (Figure 6). Jackfruit seeds in Sukamerindu 1 and Surabaya 1 accessions were oval round, while seeds in Tanjung Jaya 2 and Surabaya 1 accessions wereoval round (Figure 7). The flesh of jackfruit fruit also varies, with twisted flesh in the Sukamerindu accession and oval shape in the Surabaya accession (Table 2).

Figure 6: Fruit flesh color and shape: (a) twisted, (b) obovate

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Figure 7: Color and shape of jackfruit seeds: (a) ovoid, (b) ellipsoid

The color of the seed coat varies, beige in Surabaya 1 accession and brown in Sukamerindu 1 and Tanjung Jaya 2 accessions. Morphological variations indicated high genetic diversity. Similar variations were found in jackfruit genotypes cultivated in India (Jagadeesh *et al*., 2007; Wangchu *et al*., 2013; Dhakar *et al*., 2020), Uganda (Balamaze *et al*., 2019), and Egypt (Youssef and Khalil, 2020). These findings suggested that jackfruit quality was variable and determined by genotypes, environmental factors, and their complex interactions. This research is a preliminary study aimed at obtaining baseline data related to morphology. A physicochemical analysis will be conducted as a follow-up stage after the completion of this study. The observed morphological diversity among the jackfruit accessions showed considerable genetic variability within the local population. This morphological diversity indicates that the Sungai Serut area hosts a valuable gene pool that could be exploited in future jackfruit improvement programs.

CONCLUSION

It can be concluded that there was a morphological diversity in jackfruit plants in Sungai Serut District, Bengkulu City. Two main groups were found, namely Group I (SKM1, SK2, TJ1, TJ2) and Group II (SMR1, SMR2, TA1, TA2, SRB1, SRB2). The diversity of morphological traits of trees, leaves, and fruits found in the Sungai Serut district might be used for breeding programs to obtain superior varieties in terms of fruit quality, productivity, and environmental adaptation.

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