



EXPLORATION AND MORPHOLOGICAL CHARACTERIZATION OF SUGAR PALM (*Arenga pinnata* Merr.) IN SIKAKAP MENTAWAI ISLANDS

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ABSTRACT

Sugar palm (*Arenga pinnata*), a member of the Arecaceae (Palmae) family within the Angiospermae group, is a multifunctional plant with significant economic value. Its sap serves as a primary ingredient for palm sugar production, while its young fruit is consumed as food, its fibers are utilized for roofing, and its trunk is processed into handicrafts. However, concerns have arisen regarding the plant's declining availability due to imbalanced cultivation. A key factor contributing to the low cultivation interest among farmers is the prolonged maturation period of sugar palm. To support conservation efforts and sustainable management, morphological characterization is crucial in determining genetic relationships, which can assist breeders in preserving germplasm stability. This study aimed to assess the morphological characteristics and genetic diversity of sugar palm populations in Sikakap District, Mentawai Islands. The research was conducted from August to November 2024 using a survey method with purposive sampling. Morphological data were collected through direct observation, analyzed descriptively, and similarity relationships were determined using NTSYS Ver. 2.10 software. The exploration identified 15 accessions categorized into two groups, with genetic similarity levels ranging from 27% to 50%. A similarity coefficient of 27% indicates significant morphological variation among the observed accessions, particularly in plant height, sheath length, stem circumference, number of leaflets, leaflet width, leaflet length, and fruit diameter. The accession Pagai Selatan (PS2) exhibited the greatest morphological divergence. These findings provide valuable insights for conservation strategies and selective breeding programs aimed at maintaining the genetic diversity and sustainability of sugar palm populations.

Keyword: *accessions, cluster analysis, diversity*

ABSTRAK

[EKSPLORASI DAN KARAKTERISASI MORFOLOGI AREN (*Arenga pinnata* Merr.) DI SIKAKAP, KEPULAUAN MENTAWAI]. Aren (*Arenga pinnata*), anggota famili Arecaceae (Palmae) dalam kelompok Angiospermae, merupakan tanaman multifungsi dengan nilai ekonomi yang tinggi. Nira dari tanaman ini digunakan sebagai bahan utama pembuatan gula aren, buah mudanya dikonsumsi sebagai makanan, seratnya dimanfaatkan sebagai atap, dan batangnya diolah menjadi produk kerajinan tangan. Namun, ketersediaan tanaman aren semakin menurun akibat budidaya yang tidak seimbang. Salah satu faktor rendahnya minat petani dalam membudidayakan tanaman ini adalah masa panen yang relatif lama. Oleh karena itu, karakterisasi morfologi menjadi langkah penting dalam memahami hubungan kekerabatan tanaman ini, yang dapat membantu pemulia tanaman dalam menjaga stabilitas sumber daya genetik (plasma nutfah) serta mendukung upaya konservasi dan pengelolaan berkelanjutan. Penelitian ini bertujuan untuk mengkarakterisasi morfologi dan menganalisis tingkat keragaman tanaman aren di Kecamatan Sikakap, Kepulauan Mentawai. Penelitian dilakukan pada Agustus hingga November 2024 dengan metode survei dan pengambilan sampel secara purposive sampling. Data morfologi dikumpulkan melalui pengamatan langsung, dianalisis secara deskriptif, dan hubungan kekerabatan antaraksesi dianalisis menggunakan perangkat lunak NTSYS Ver. 2.10. Eksplorasi ini menemukan 15 aksesori yang dikelompokkan ke dalam dua grup dengan tingkat kesamaan genetik berkisar antara 27% hingga 50%. Koefisien kesamaan sebesar 27% menunjukkan adanya perbedaan karakter morfologi yang signifikan, terutama pada tinggi tanaman, panjang pelepah, lingkaran batang, jumlah anak daun, lebar dan panjang anak daun, serta diameter buah. Aksesori Pagai Selatan (PS2) menunjukkan perbedaan morfologi paling jauh dibandingkan aksesori lainnya. Hasil penelitian ini memberikan wawasan penting bagi strategi konservasi dan program pemuliaan selektif guna menjaga keanekaragaman genetik dan keberlanjutan tanaman aren.

Kata kunci: *aksesi, analisis klaster, keragaman*

INTRODUCTION

The Sugar palm (*Arenga pinnata* Merr.) is a member of the palm family, known for its wide-ranging ecological and economic functions. Nearly all parts of the sugar palm are utilized, contributing to its significance. Sugar palm exhibit remarkable adaptability to diverse agroclimatic conditions, thriving in both lowland areas and at altitude of up to 1,400 meters above sea level (Maliangkay, 2007).

The sugar palm belongs to the same botanical family as other important tropical plant such as coconut, date palm, oil palm and sago (Harjadi, 1986). The primary product of the sugar palm is its sap, which is obtained by tapping male flowers. This sap is processed into various products, including palm sugar, soft drinks, vinegar and alcohol (Antaatmadja, 1989; Mulyani *et al.*, 2022; Lempang, 2012). Additionally, the sugar palm provides other valuable products, such as the edible palm fruit (from female flowers) and aren flour. The latter is used as an ingredient in foods such as cakes, bread and biscuits, derived from processing the plant's stem pith. The plant's by products also serve as a potential source of bioethanol (Effendi, 2010). As the utilization of sugar palm as a source of carbohydrates, sugar, alcohol, and biofuel expands, concern have emerged regarding the potential scarcity of the plant. This is due to the lengthy harvest cycle, which typically range from 7 to 12 years (Manaroinsong, 2006).

Despite its significance, the study of sugar palm germplasm in Indonesia remains limited. Germplasm management begins with exploration, which involves identifying, collecting, and studying specific germplasm types to prevent their extinction. Characterization and documentation are integral components of this exploration process (Zulputra, 2019). Exploration activities are essential for enriching plant genetic resources, which can subsequently be developed and utilized by local communities (Maxiselly *et al.*, 2016).

Exploration, coupled with characterization, serves as the foundational step in selecting superior accessions for further development within sugar palm breeding programs (Surahman *et al.*, 2009). Morphological characterization is critical for the conservation of sugar palm germplasm, and the resulting data can be employed to identify and desirable traits within sugar palm populations (Hartati & Darsana, 2015).

Diversity among accessions can be identified through both morphological traits and molecular markers. Morphological characterization, being visually observable, offers a straightforward method for assessing plant diversity (Kuswandi *et al.*, 2014; Zulfahmi *et al.*, 2015). One of the key advantages of using morphological markers is their ability to directly identify superior traits of specific accessions (Das *et al.*, 2012; Hartati, 2015).

Sikakap, located within in the Mentawai Islands, holds significant potential for the development of sugar palm cultivation, as the plants naturally grows in the region. Locally, the sugar palm is referred to as "Paula". Given the numerous benefits of the sugar palm, its cultivation could substantially contribute to improving the economy well-being of local farmers. Therefore, this exploration aims to assess and harness the potential of superior sugar palm varieties in the area.

The objective of this study is to obtain comprehensive information on the morphological diversity of sugar palm germplasm accessions in Sikakap, Mentawai Islands.

MATERIALS AND METHODS

The research was conducted from August to November 2024 in Sikakap, Mentawai Islands in 3 areas, namely; Pagai Utara, Pagai Selatan and Matobe (Figure 1).



Figure 1. Location of sugar palm exploration in Sikakap. In three areas, namely; Pagai Utara (1), Matobe (2) and Pagai Selatan (3)

Observations of morphological characters were carried out directly at the exploration location, and fruit samples were brought to be observed on campus. The observed variables were taken from the modified Descriptor for coconut (IPGRI, 1995) and from the description of registered coconut varieties. This was done considering that the descriptor for sugar palm plants was not yet available. The observed variables included: Plant Height, Stem Circumference, Stem Bark Color, Sheath Length, Rachis Length, Leaf Stalk Length, Number of Leaflets, Leaflet Length, Leaflet Width, Root Height from Soil Surface, Number of Fruit Bunches, Number of Fruit Strings, Fruit Diameter, Weight, Seed Diameter, Number of Seeds, and Weight of Seed for fifteen accession.

Similarity analysis aims to see the proximity between sugar palm accessions. For similarity analysis, a program from statistical software, NTSYS Ver.2.10, will be used. The results of the similarity analysis

with this program will be displayed in the form of a dendrogram.

RESULTS AND DISCUSION

This research was conducted in Sikakap District, Mentawai Regency. The boundaries of Sikakap District are as follows: North: Pagai Utara District and Mentawai Strait, East: Mentawai Strait, South: Pagai Selatan District, West: Pagai Utara District. Sikakap District is divided into 3 villages, namely: Matobe, Sikakap and Taikako. This district is located at 02037'12'' - 03055'04'' South Latitude and 100016'12'' East Longitude. Sikakap District has an area of 27,854 ha. The exploration results obtained 15 sugar palm accessions in Sikakap Mentawai Islands. The 15 accessions were found in 3 regions, namely Pagai Utara, Pagai Selatan and Matobe. The results of the analysis showed that 15 sugar palm accessions were grouped into two main groups, namely group 1 consisting of three accessions MT5, MT6, PS2, while the rest were included in group 2. The similarity coefficient between the two groups of aren accessions from Sikakap Mentawai Islands is around 27-50 % (Figure 2).

The coefficient matrix values contained in the dendrogram based on the scoring of 15 accessions with sugar palm show that the larger of number, the higher the similarity possessed by the sugar palm and if the smaller the number, the level of similarity is lower. The closest similarity is Matobe 3 (MT3) and Matobe 4 (MT4), namely 50%. Meanwhile, the most distant similarity relationship is Pagai Selatan (PS2), Matobe 5 (MT5) and Matobe 6 (MT6), namely 27%.

The kinship relationship based on the similarity coefficient in the dendrogram shows that there are accessions that are not closely related. The similarity distance is said to be close if it has a value of more than 60% or 0.60. The dendrogram also shows that there are dissimilarities in the accessions based on the morphological characters used as kinship analysis data. This can be seen from the similarity coefficient which reached 0.27, which means that 27% of the characters observed were not the same.

Differences character between sugar palm accessions in group 1 and group 2 include, the height of plants in group 1 is categorized as low, while group 2 is medium and high. For the length of the leaf stalk, it was found to be short, the stem circumference was 23-31 cm, the number of leaflets

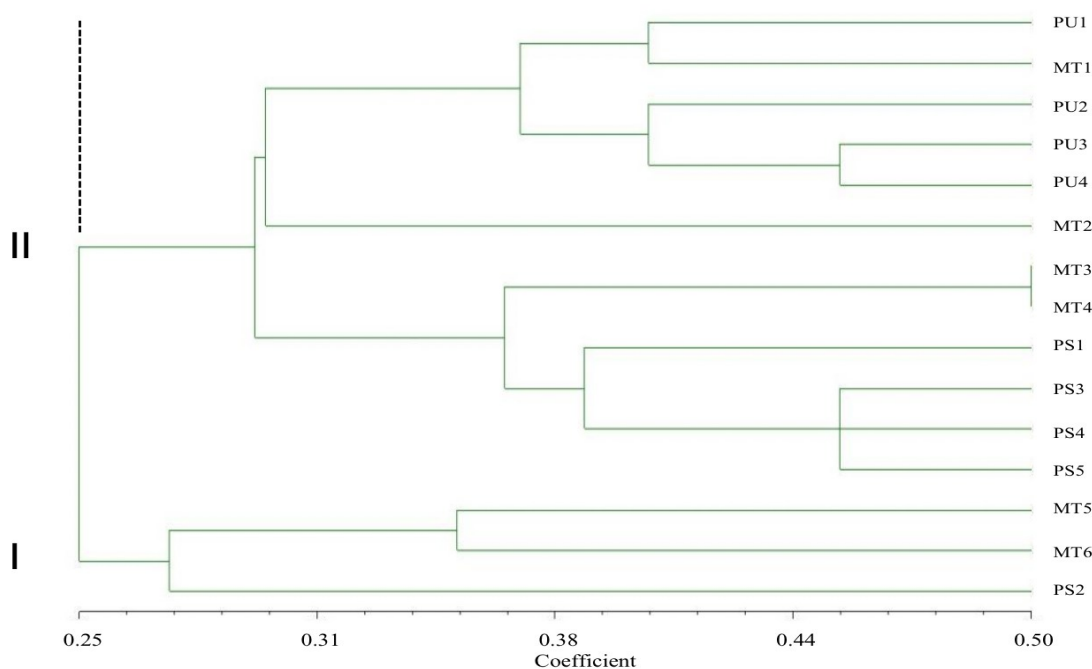


Figure 2. Dendrogram grouping of 15 sugar palm accessions from Sikakap

Note : I-II group ; group II : PU1 (*Pagai Utara* 1), MT1 (*Matobe* 1), PU2 (*Pagai Utara* 2), PU3 (*Pagai Utara* 3), PU4 (*Pagai Utara* 4), MT2 (*Matobe* 2), MT3 (*Matobe* 3), MT4 (*Matobe* 4), PS1 (*Pagai Selatan*

in leaf stalk was small, while in group 2 the length of the leaf stalk was categorized as medium and long, the number of leaflets was large. The same thing was also found in the width of the leaflets, the length of the leaflets, and the diameter of the fruit (Table 1).

Table 2. Distinguishing characters between sugar palm accessions of Groups 1 and 2

Character	Group 1	Group 2
Plant height	medium, high	low
Sheath length	medium, long	short
Stem circumference	46-62 cm	23-31 cm
Number of leaflets	186	140
Leaflet width	7-9 cm	4-5 cm
Leaflet length	120-132cm	105-116 cm
Fruit diameter	39 mm	29 mm

Qualitative and quantitative observations of the morphological diversity of sugar palm germplasm from the Sikakap, Mentawai Islands can be seen from various variables. The width of the leaflets in group one is 4-5 cm and group 2 is 7-9 cm. The circumference of the stem also varies, some are small, namely 23-31 cm and some are large, 46-62 cm (Figure 3).



Figure 3. Performance of sugar palm trees in Sikakap, Mentawai Islands
a) Pagai Utara, b) Matobe, c) Pagai Selatan

Similarity analysis is a determining factor of how close and far the relationship of similarities between plants using their morphological traits (Fitriana *et al.*, 2017). This analysis is carried out based on qualitative and quantitative characters. According to Weeden & Wendel (1989), genetic similarity analysis based on morphological and agronomic characters has several weaknesses such as the influence of quite large environmental factors, and dominant recessive gene interactions, but this analysis is expected to describe the existence of genetic variability. Therefore, further kinship analysis can be carried out based on molecular markers, so that information about the genetic constitution of each genotype group formed can be known.

Similarity analysis of 15 sugar palm accessions in three sub-districts of Sikakap, Mentawai Islands was analyzed using the Numerical Taxonomy and Multivariate Analysis System (NTSYS) version 2.10. If the coefficient value is greater in the dendrogram, it indicates that the level of similarity is closer, while if the coefficient value is small, it indicates that the similarity of the variants being compared is also smaller. According to Hesnananda (2017), similarity analysis in plants with a value of 50% is moderate, greater than 50% is said to be high and below 50% is interpreted as low.

Morphological diversity of germplasm accessions is usually identified using multivariate analysis, such as cluster analysis or principal component analysis. Cluster analysis is used to group germplasm accessions and identify the distance between accessions. Grouping of accessions in cluster analysis is based on similarity measures (Afza *et al.*, 2018; Sitaesmi *et al.*, 2018; Fitriana *et al.*, 2017; Rahajeng, 2015; Maji *et al.*, 2012).

CONCLUSIONS

The conclusion of the exploration activities that have been carried out in the Sikakap sub-district of the Mentawai Islands found 15 accessions of sugar palm plants spread across three areas as follows, Pagai Utara, Pagai Selatan and Matobe. Analysis of the diversity of these 15 plant accessions, there are 2 main groups, namely group 1 consisting of *Matobe 5* (MT5), *Matobe 6* (MT6), *Pagai Selatan* (PS2), while the rest are included in group 2. Then from the 17 morphological characters that have been observed, the coefficient of diversity is obtained, namely 27-50%. A similarity coefficient of 27% indicates that there are dissimilarities in characters between the accessions observed, plant height, sheath length, stem circumference, number of leaflets, leaflet width, leaflet length, and fruit diameter, which is *Pagai Selatan* (PS2) interpreted as having the furthest dissimilarity.

REFERENCES

- Afza, H., Andarini, Y. & Herlina, L. (2018). Keragaman anakan seratus aksesi plasma nutfah padi gogo lokal. *Buletin Plasma Nutfah*, 24(1), 9–18. DOI: <https://doi.org/10.21082/blpn.v24n1.2018.p9-18>.
- Antaatmadja, S. (1989). Aspek sosial ekonomi tanaman aren. *Jurnal Penelitian Hasil Hutan*.6(1),63-69.
- Das, S.S., Sudarsono, Djoefrie, B. & Yudiwanti W.E. K. (2012). Keragaman spesies pala (*Myristica* spp.) Maluku Utara berdasarkan penanda morfologi dan agronomi. *Zuriat*, 23(2). DOI: <https://doi.org/10.24198/zuriat.v23i2.6876>.

- Effendi, D.S., (2010). Prospek Pengembangan tanaman Aren (*Arenga pinnata* Merr.) mendukung kebutuhan bioetanol di Indonesia. Pusat Penelitian dan Pengembangan Perkebunan. *Jurnal Perspektif*, 9(1), 36-46.
- Fitriana, R., Yulistyarini, T., Soegianto, A. & Ardiarini, N.R. (2017). Hubungan kekerabatan plasma nutfah bambu berdasarkan karakter morfologi. *Jurnal Produksi Tanaman*, 5(5), 812–820.
- Hartati, S. & Darsana, L. (2015). Karakterisasi anggrek alam secara morfologi dalam rangka pelestarian plasma nutfah. *Jurnal Agronomi Indonesia*, 43(2), 133–139. DOI: <https://doi.org/10.24831/jai.v43i2.10419>.
- Hesananda, R., Warnars, H.L.H.S. & Sianipar, N.F. (2017). Supervised classification karakter morfologi tanaman Keladi Tikus (*Typhonium flagelliforme*) menggunakan Database Management System. *Jurnal Sistem Komputer*. 7(2). 50-58.
- Islam, M. Z., Ali, M. P., Khalequzzaman, M., Prince, M. F. R. K., Siddique, M. A., Rashid, E. S. M. H., Pittendrigh, B. R. (2018). Diversity and population structure of red rice germplasm in Bangladesh. *PLoS ONE*, 1–12. DOI: <https://doi.org/10.1371/journal.pone.0196096>.
- IPGRI. (1995). Descriptors for Coconut (*Cocos nucifera* L. International Plant Genetic Resources Institute. Roma. Italy. <https://indoplasma.or.id/deskriptor.htm>
- Kuswandi, Sobir, W. B. S. (2014). Keragaman genetik plasma nutfah Rambutan di Indonesia berdasarkan karakter morfologi. *Jurnal Hortikultura*, 24(4), 289–298. <https://doi.org/10.21082/jhort.v24n4.2014.p289-298>.
- Lemgang, M. (2012). Pohon Aren dan Manfaat Produksinya. *Info Teknis EBONI*, 9(1), 37-54. DOI: <https://doi.org/10.20886/buleboni.4993>.
- Manoroinsong, E., Maliangkay R.B. & Matana, Y.R. (2006). Observasi Produksi Nira Aren (*Arenga pinnata*) di Kecamatan Langowan, Kabupaten Minahasa Induk, Provinsi Sulawesi Utara. *Buletin Palma*, 1(31), 111-115. <https://repository.pertanian.go.id/server/api/core/bitstreams/a6e6d3ea-5e5d-4872-b5bb-7274f6415761/content>.
- Mulyani, L.S., Sumiati, Y., Mulyaningsih, S. (2022). Kualitas nata de nira (*Arenga pinnata*) melalui lamanya fermentasi. *Jurnal Life Science : Pendidikan dan Ilmu Pengetahuan Alam*. 7 (2), 2-6. DOI: <https://doi.org/10.31980/jls.v4i1.1659>.
- Maji, A. T., Shaibu, A. A. & Cereals, N. (2012). Application of principal component analysis for rice germplasm characterization and evaluation. *Journal of Plant Breeding and Crop Science*, 4(6), 87–93. DOI: <https://doi.org/10.5897/JPBSCS11.093>
- Rahajeng, W. (2015). Pendugaan keragaman karakter morfologi 50 aksesori plasma nutfah ubi jalar. In *Seminar Nasional Masyarakat Biodiversitas Indonesia*, 1, 904–909). DOI: <https://doi.org/10.13057/psnmbi/m010444>.
- Sitaresmi, T., Yunani, N. & Daradjat, A. (2018). Analisis kemiripan morfologi varietas unggul padi periode pelepasan 1980 – 2011. *Buletin Plasma Nutfah*, 24(1), 31–42. DOI: <https://10.21082/blpn.v24n1.2018.p31-42>.
- Surahman, M., Santosa, E. & Fifin, N. (2009). Karakterisasi dan analisis gerombol plasma nutfah jarak pagar indonesia dan beberapa negara lain menggunakan marka morfologi dan molekuler. *J. Agron. Indonesia*, 37(3), 256–264. DOI: <https://10.24831/jai.v37i3.1243>.
- Tenda, E.T. & Maskromo, I. (2012). Karakteristik morfologi dan potensi produksi Aren Genjah Kutim. Balai Penelitian Tanaman Palma Jalan Raya Mapanget. *Buletin Palma*, 13(2), 115-121.
- Ulimaz, T. A. Ustari, D. Aziza, V. Suganda, T. Concibido, V. Levita, J. & Karuniawan, A. (2020). Keragaman genetik Bunga Telang (*Clitoria ternatea*) asal Indonesia berdasarkan karakter bunga dan komponen hasil pada dua lahan berbeda. *Jurnal AgroBiogen*, 16(1), 1–6. DOI: <https://doi.org/10.33387/jpk.v2i1.6284>.
- Weeden, N.F., Wendel, J.F. (1989). Genetic of plan isozymes. *Dioscoride Press.*, Porland, Orgegon. 46-72. DOI: <https://doi.org/10.1016/b978-0-12-472704-5.50028-8>.
- Zulfahmi, Suranto & Mahajoeno, E. (2015). Karakteristik tanaman labu kuning (*Cucurbita moschata*) berdasarkan penanda morfologi dan pola pita isozim peroksidase. In *Prosiding Seminar Nasional Biotik 2015*, 266–273. DOI: <http://dx.doi.org/10.22373/pbio.v3i1.2694>.
- Zulputra. (2019). Eksplorasi padi gogo lokal di Kecamatan Rambah Samo. *Jurnal Sungkai*, 7 (1), 52–60. DOI: <https://doi.org/10.30606/js.v7i1.1735>.