



Diversity of Edible Fruit Species in Gunung Leuser National Park Area, Aceh Tamiang

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Abstract: Aceh Tamiang Regency, located in the northern part of Sumatra Island with an area of 1.957.02 km², is part of the Leuser Ecosystem, famously known as the Gunung Leuser National Park-TNGL. The remarkable biodiversity in TNGL has earned it recognition as a national park and wildlife sanctuary. Threats to this biodiversity include illegal logging, land conversion, hunting, and wildlife trafficking. This study aimed to identify the diversity of edible fruit species in the Aceh Tamiang region of TNGL as an initial step in conservation and utilization efforts for fruit biodiversity. The genetic resources of edible fruit plants in this area hold significant potential for enhancing the quality and quantity of fruits in Indonesia. Hence, conservation and sustainable management are crucial for fruit plant development. The research was conducted in Bandar Pusaka, Tamiang Hulu, and Tenggulun. The exploration discovered 81 species of edible fruits from 27 families. Tenggulun had the highest number of species (61 species), followed by Bandar Pusaka (53 species) and Tamiang Hulu (44 species). Species like *Mangifera odorata* Griff., *Garcinia mangostana* L., *Pometia pinnata* J.R. Forst. & G. Forst., and others were found in all locations. The highest diversity index was in Tenggulun (H' 3.31), followed by Bandar Pusaka (2.88), and the lowest in Tamiang Hulu (2.39). Species evenness ranged from 0.63 to 0.81, indicating moderate and stable evenness levels. Species dominance was low, with values ranging from 0.007-0.009.

Keywords: Biodiversity; Edible fruits; TNGL

Introduction

Aceh Tamiang is one of the districts in Aceh Province in the northern part of Sumatra Island, with an area of 1.957.02 km². This area is part of the Leuser Ecosystem, known as TNGL. The area covers several regions of Aceh, and one of them is located in Aceh Tamiang Regency with coordinates 03°53'18.81"-04°32'56.76" North latitude and 97°43'41.51"-98°14'45.41 East longitude. Tenggulun sub-district is the largest sub-district in Aceh Tamiang district, with an area of 295.55 km² or 15.10% of the Aceh Tamiang area. The district with the furthest distance from the capital is Bandar Pusaka, which is 31 km². (BPS Aceh Tamiang, 2022). Aceh Tamiang TNGL is designated as an ASEAN

Heritage Park recognized by ASEAN countries (Hadisiswoyo, 2018).

The Aceh Tamiang TNGL area is so uniquely biodiverse that it has been designated a national park and nature reserve. Efforts to protect biodiversity and improve livelihoods in and around this area have the support of various international organizations. Unique to this biodiversity are the edible fruits. These plant species include all fruit-bearing perennial plants that can be eaten fresh when the fruit is unripe or ripe (Uji, 2007). Data on species diversity and under-species of edible fruit plants in Aceh Tamiang TNGL are currently limited.

Biological exploitation, illegal logging, conversion of forest areas to other areas, poaching and illegal trade

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are factors that threaten biodiversity. Moge et al., (2001) explained that efforts that can encourage efforts to save biological resources with the reality of increasing threat and extinction of biological resources, determining the rarity status of a species is essential. The level of threat and extinction of Indonesian plant species is the highest globally and has become a hot spot for animal extinction. There are 240 rare plant species in Indonesia, some of which are cultivated species, such as 52 orchid family species, 11 rattan species, nine bamboo species, nine areca nut species, six durian species, four nutmeg species, and three mango species (Malik et al., 2020).

Exploration and conservation of edible fruit biodiversity resources are essential to save genetic diversity in Aceh Tamiang District. Knowledge of genetic resources and their conservation is needed to anticipate the extinction of existing genetic resources (Noor et al., 2015). Loss of genetic resources limits efforts to improve plant characteristics and increases the risk of crop loss due to new disease attacks or unfavorable environmental conditions (Chahal & Gosal, 2003). Information on the diversity of edible fruit species is vital as a basis for policy management and utilization of plant genetic resources to realize the welfare of society.

Conservation and utilization of genetic resources are essential components in breeding to improve the quality and production of fruits. This study aimed to identify the diversity of species of edible fruits in the Aceh Tamiang TNGL area. This information will save rare edible fruit plants while increasing the diversity of edible fruit species in Aceh Tamiang Regency.

Method

Time and Place

The research was conducted from August to September 2023 in the Aceh Tamiang TNGL area in 3 locations: Bandar Pusaka, Tamiang Hulu and Tenggulun Districts (Table 1). The three locations were chosen because they are areas directly adjacent to the Aceh Tamiang TNGL forest (Figure 1).

Data Collection

Exploration was conducted using the exploration method, followed by the exploration method of Rugyah et al. (2004), namely exploring forest areas and residential areas. Data on the biodiversity of edible fruit plants were obtained from exploring the forest area restoration station and interviewing the station keeper to find the condition of edible fruit plant biodiversity resources in the forest. All species found were recorded, documented, and analyzed descriptively. Plant parts collected from the field were made into herbarium specimens of each species, as many as three duplicates following the Van Steenis and Kartawinata collection and preservation method (Suwardi et al., 2023).

Table 1. Research location

Research location	Coordinates
Bandar Pusaka	4°17'00.9 "N 97°52'53.8 "E
Tamiang Hulu	4°05'28.0 "N 97°50'45.2 "E
Tenggulun	4°03'04.4 "N 97°54'40.7 "E

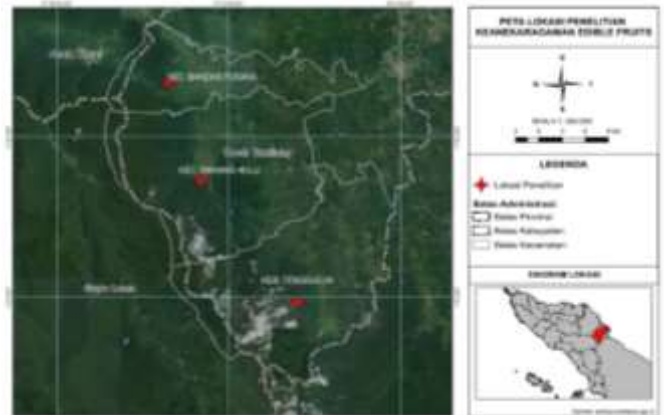


Figure 1. Location of Edible Fruits Plant Exploration in Aceh Tamiang TNGL

Data Analysis

Diversity Index

Species diversity of edible fruits plants is determined using the Shannon-Wiener index (H^I), which is calculated by the formula used by (Elfrida et al., 2020).

$$H^I = \sum_{i=1}^S \left[\left(\frac{n_i}{n} \right) \ln \left(\frac{n_i}{n} \right) \right] \tag{1}$$

Description:

- H^I : Shannon-Wiener diversity index
- S: Total number of species at each site
- N_i : Number of individuals of the i -th species
- N: Total number of individuals

Diversity index categories:

- $H^I \leq 1$: low diversity
- $1 < H^I < 3$: moderate diversity
- $H^I \geq 3$: high diversity

Evenness Index

The evenness index (E) was calculated using the Magurran (2004) Formula.

$$E = \frac{H^I}{H_{max}^I} = \frac{H^I}{\ln S} \tag{2}$$

Description:

- E: Evenness Index
- H^I : Shannon-Wiener diversity index
- S: Total number of species at each site
- Ln: Natural logarithm

Evenness index categories:

- $0 < E \leq 0.5$: small evenness, depressed community

0.5 < E ≤ 0.75: moderate evenness, unstable community
 0.75 < E ≤ 1: high evenness, stable community

Dominance Index

A high dominance index and a low dominance index indicate the dominance of one species over another. The dominance index formula was used by Odum (1996).

$$C = \sum_{i=1}^s Pi^2 \tag{3}$$

Description:

C: Dominance index

Pi: Proportion of individuals in the species

I: 1, 2, 3....., n

Dominance index category:

0 < C ≤ 0.5: low dominance

0.5 < C ≤ 0.75: medium dominance

0.75 < C ≤ 1: high dominance

Result and Discussion

Edible fruit plant species in Aceh Tamiang TNGL

The results of the exploration of edible fruit plants in 3 locations of the TNGL area, namely Bandar Pusaka, Tamiang Hulu and Tenggulun Districts in Aceh Tamiang Regency, obtained a total of 81 species of edible fruit plants consisting of 27 families. The highest number of species was found in Tenggulun, with 61 species from 21 families, followed by Bandar Pusaka, with 53 species

from 21 families, and Tamiang Hulu, with 44 species from 19 families (Figure 2).

The most prominent families of edible fruits are Phyllanthaceae and Moraceae, with nine species each, followed by Myrtaceae and Sapindaceae, with six species each, and Anacardiaceae, Clusiaceae, Malvaceae, and Meliaceae, with five species each. The other families consist of 1-4 species each. A total of 26 species of edible fruits were found living in the three research sites (Table 2), including *Mangifera odorata* Griff., *Garcinia mangostana* L., *Archidendron jiringa* (Jack) I.C. Nielsen, *Flacourtia rukam* Zoll. & Moritzi, *Melastoma malabathricum* L., *Artocarpus integer* (Thunb.) Merr., *Syzygium malaccense* (L.) Merr. & L.M. Perry, and *Pometia pinnata* J.R. Forst. & G. Forst. In addition to these species, other species were found in different locations (Table 2).

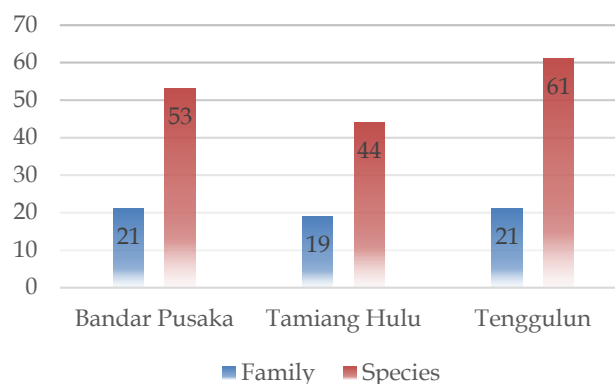


Figure 2. Number of edible fruit species in Bandar Pusaka, Tamiang Hulu, and Tenggulun.

Table 2. Species of edible fruits in Bandar Pusaka, Tamiang Hulu, and Tenggulun.

Family	Species	Local name	Area study		
			BP	TH	TG
Anacardiaceae	<i>Mangifera foetida</i> Lour.	Kweni	-	√	√
	<i>Mangifera laurina</i> Blume	Asam pauh	√	-	√
	<i>Mangifera odorata</i> Griff.	Mancang	√	√	√
	<i>Mangifera indica</i> L.	Mangga biasa	√	√	√
	<i>Anacardium occidentale</i> L.	Jambu mete	√	-	√
Apocynaceae	<i>Voacanga foetida</i> (Blume) Rolfe	Telur kambing	√	-	-
Burseraceae	<i>Santiria laevigata</i> Blume	Kedondong tunjuk	√	√	-
Caricaceae	<i>Carica papaya</i> L.	pepaya	√	√	√
Clusiaceae	<i>Garcinia atroviridis</i> Griff. ex T.Anderson	Asam gelugur	-	-	√
	<i>Garcinia nigrolineata</i> Planch. ex T.Anderson	Peralih	√	-	-
	<i>Garcinia celebica</i> L.	Asam kandis	-	-	√
	<i>Garcinia mangostana</i> L.	Manggis biasa	√	√	√
Cucurbitaceae	<i>Garcinia parvifolia</i> (Miq.) Miq.	Unknown	-	-	√
	<i>Momordica balsamina</i> L.	Pare hutan	-	√	√
Euphorbiaceae	<i>Cheilosa montana</i> Blume	Unknown	-	√	-
	<i>Mallotus philippensis</i> (Lam.) Müll.Arg.	Balek angina	√	-	-
Fabaceae	<i>Archidendron borneense</i> (Benth.) I.C.Nielsen	Jengkol hutan	-	√	√
	<i>Archidendron jiringa</i> (Jack) I.C.Nielsen	Jengkol	√	√	√
Fagaceae	<i>Lithocarpus echinulatus</i> Soepadmo	Gasing	√	-	-
	<i>Lithocarpus indutus</i> (Blume) Rehder	Gasing	-	-	√
	<i>Castanopsis costata</i> (Blume) A.DC.	Berangan gunung	-	-	√

Family	Species	Local name	Area study		
			BP	TH	TG
Flacourtiaceae	<i>Flacourtia rukam</i> Zoll. & Moritzi	Rukam	√	√	√
Malvaceae	<i>Boschia griffithii</i> Mast.	Durian enggang	√	-	-
	<i>Durio conatus</i> Priyanti	Durian merah	-	-	√
	<i>Microcos latistipulata</i> (Ridl.) Burret	Unknown	-	-	√
	<i>Durio oxleyanus</i> Griff.	Durian daun	√	-	√
Melastomataceae	<i>Durio zibethinus</i> L.	Durian biasa	√	√	√
	<i>Melastoma malabathricum</i> L.	Sikaduduk	√	√	√
Meliaceae	<i>Miconia crenata</i> (Vahl) Michelang.	Sikaduduk bulu	√	√	√
	<i>Aglaia tomentosa</i> Teijsm. & Binn.	Unknown	-	√	√
Moraceae	<i>Chisocheton patens</i> Blume	Unknown	√	-	√
	<i>Dysoxylum alliaceum</i> (Blume) Blume	Unknown	√	√	-
	<i>Dysoxylum cyrtobotryum</i> Miq.	Unknown	√	√	-
	<i>Sandoricum koetjape</i> (Burm.f.) Merr.	Setui	√	-	√
	<i>Artocarpus rigidus</i> Blume	Terap	√	√	√
	<i>Artocarpus integer</i> (Thunb.) Merr.	Cempedak	√	√	√
	<i>Artocarpus elasticus</i> Reinw. ex Blume	Terap	√	√	√
Muntingiaceae	<i>Ficus altissima</i> Blume	Ara	√	√	√
	<i>Ficus fistulosa</i> Reinw. ex Blume	Ara	√	-	√
	<i>Ficus globosa</i> Blume	Ara	√	√	√
	<i>Ficus lepicarpa</i> Blume	Ara	-	√	√
	<i>Ficus racemosa</i> L.	Ara	√	√	√
	<i>Ficus virens</i> Aiton	Ara	√	√	√
Muntingiaceae	<i>Muntingia calabura</i> L.	Seri	√	√	√
Musaceae	<i>Musa acuminata</i> Colla	Pisang hutan	-	-	√
	<i>Musa troglodytarum</i> L.	Pisang tunjuk Langit	-	-	√
Myristicaceae	<i>Knema latericia</i> Elmer	Dedarah	√	-	-
	<i>Knema losirensis</i> W.J.de Wilde	Dedarah	√	-	√
	<i>Knema conferta</i> (King) Warb.	Pala hutan	-	√	√
	<i>Myristica elliptica</i> Wall. Ex Hook. f. & Thomson	Pala hutan	√	-	√
Myrtaceae	<i>Syzygium cerasiforme</i> (Blume) Merr. & L.M.Perry	Jambu hutan	√	√	-
	<i>Syzygium cumini</i> (L.) Skeels	Jambu keling	√	-	-
	<i>Syzygium polyanthum</i> (Wight) Walp	Salam	√	-	-
	<i>Syzygium aqueum</i> (Burm.f.) Alston	Jambu air	√	√	√
	<i>Psidium guajava</i> L.	Jambu biji	√	√	√
Passifloraceae	<i>Syzygium malaccense</i> (L.) Merr. & L.M.Perry	Jambu Bol	√	√	√
	<i>Adenia grandifolia</i> Ridl	Unknown	√	√	√
Phyllanthaceae	<i>Passiflora foetida</i> L.	Rambusa	√	√	√
	<i>Aporosa benthamiana</i> Hook. f.	Kayu asam	-	√	-
	<i>Baccaurea macrophylla</i> (Mull. Arg) Mull. Arg	Tampoi	√	-	-
	<i>Baccaurea costulata</i> (Miq) Mull. Arg	Tampoi	-	√	-
	<i>Baccaurea lanceolata</i> (Miq.) Mull.Arg	Kepong	√	-	√
	<i>Baccaurea macrocarpa</i> (Miq.) Müll.Arg.	Tampoi	-	√	√
	<i>Baccaurea racemosa</i> (Reinw. ex Blume) Müll. Arg	Tampoi/menteng	-	-	√
	<i>Baccaurea angulata</i> Merr.	Boh dara	-	√	√
	<i>Baccaurea parviflora</i> (Müll.Arg.) Müll.Arg.	Mata Rusa	√	-	√
	<i>Baccaurea polyneura</i> Hook. f.	Jentik	-	-	√
Proteaceae	<i>Helicia robusta</i> (Roxb.) R.Br. ex Blume	Unknown	√	-	-
Rosaceae	<i>Prunus arborea</i> (Blume) Kalkman	Ceri	√	√	√
	<i>Rubus alceifolius</i> Poir.	Beri hutan	√	√	√
	<i>Rubus moluccanus</i> L.	Beri	√	√	√
Rubiaceae	<i>Anthocephalus cadamba</i> Miq.	Unknown	-	-	√
Sapindaceae	<i>Lepisanthes fruticosa</i> (Roxb.) Leenh.	Rambutan biawak	-	-	√
	<i>Nephelium cuspidatum</i> Blume	Rambutan hutan	√	-	√
	<i>Pometia pinnata</i> J.R. Forst. & G. Forst.	Matoa hutan	√	√	√
	<i>Nephelium lappaceum</i> L.	Rambutan biasa	√	√	√
	<i>Nephelium cuspidatum</i> Blume	Rambutan hutan	-	√	-

Family	Species	Local name	Area study		
			BP	TH	TG
Sapotaceae	<i>Xerospermum noronhianum</i> (Blume) Blume	Rambutan monyet	-	-	√
	<i>Pleioluma firma</i> (Miq.) Swenson	Unknown	√	-	-
Staphyleaceae	<i>Dalrympelea sphaerocarpa</i> (Hassk.) Nor-Ezzaw.	Unknown	-	-	√
Vitaceae	<i>Causonis trifolia</i> (L.) Mabb. & J.Wen	Anggur hutan	-	√	-
Total			53	44	61

Notes: BP (Bandar Pusaka), TH (Tamiang Hulu, TG (Tenggulun), √ (Present), - (Absent)

The exploration results in 3 Aceh Tamiang TNGL area locations were 81 species higher than the 55 species of local fruit plants reported by (Navia et al., 2019). Navia's research location in the Leuser Ecosystem in Aceh Tamiang Regency, namely in Bandar Pusaka and Tamiang Hulu Districts, 47 species from 17 families, Tenggulun 42 species from 16 families, Sekerak 39 species from 15 families and finally Manyak Payed 45 species from 18 families. The existence of local fruits is spread across the five research locations, ranging from wild ones in forest areas to cultivated ones in people's yards. Some of the plant species found in the yards are seeds obtained from the forest, i.e., during the forest fruit season, people who look for fruit then plant the seeds around the houses. According to the local community, some forest fruit plant species, such as *Baccaurea* sp, *Durio* and *Mangifera laurina* trees, are challenging to find (Navia et al., 2019). This is influenced by various factors, especially the problem of converting forest land into oil palm plantations, such as in Tamiang Hulu, Manyak Payed and Bandar Pusaka Districts, and massive logging of forest timber, such as Tenggulun District. However, if left unchecked and there is no follow-up, the germplasm or biodiversity of edible fruits will be lost with the exploitation of biodiversity, illegal logging, conversion of forest areas into other areas, hunting, and illegal trade are some of the factors that cause the threat of biodiversity. Efforts that can encourage the rescue of existing natural resources, and the reality of the increasing threat and extinction of biological resources, the status of the rarity of a species is determined.

The sustainability of edible fruit biodiversity is influenced by the culture and traditional knowledge of local communities, especially related to the utilization of these plants. Traditional ethnobotanical knowledge of local communities contributes positively to efforts to conserve biodiversity in a region (Hanazaki et al., 2018). In general, edible fruit plant species are still widely cultivated and utilized by the surrounding community even though the management has not been optimal. The community cultivates the edible fruit plants by planting them in fields adjacent to the forest. In addition, some people plant edible fruits plants in their yards. The community utilizes edible fruit plants, such as table fruit, to meet nutritional needs; they are also used as

shade trees around the yard and road, such as *Pometia pinnata* J.R. Forst. & G. Forst and *Syzygium malaccense* (L.) Merr. & L.M. Perry.

Analysis of species diversity, evenness and dominance at each exploration site showed that the values of species diversity index (H') ranged from 2.39-3.31, evenness index (E) ranged from 0.63-0.81, and dominance index (C) ranged from 0.007-0.009 (Table 3).

Table 3. Index of Diversity, Evenness, and Dominance

Research location	Total	H'	E	C
Bandar Pusaka	53	2.88	0.72	0.008
Tamiang Hulu	44	2.39	0.63	0.007
Tenggulun	61	3.31	0.81	0.009

Diversity Index

The diversity index of a plant community is influenced by the number of species and individuals of each species (species richness) in the community. The high and low index varies based on the number of species and individuals present (Hidayat, 2017). The results of the species diversity index calculation in Tenggulun amounted to 3.31, classified as high, followed by Bandar Pusaka at 2.88 and Tamiang Hulu at 2.39, classified as medium. The high index of species diversity is determined by the number of species that live in that location; the more species, the higher the diversity index.

Tenggulun occupies a high diversity index position compared to the other two locations because Tenggulun has a large river ecosystem, so many edible fruit plants are found along the riverbank. The existence of rivers is very beneficial for plants because water is the primary source of plant life. Rahmanian & Irawanto (2022) emphasized that rivers primary function is to provide water all the time. Therefore, the diversity of plants around the river is very abundant.

Bandar Pusaka has a diversity index ranked second after Tenggulun due to the diversion of land functions into large-scale oil palm plantations. Many edible fruit plants are displaced or lost because people are more concerned with planting oil palm plants in the TNGL area. Land conversion into oil palm plantations has both positive and negative impacts. Nahlunnisa et al., (2017) explained that oil palm plantations are the community's livelihood, provide alternative energy sources, and

contribute to the national economy. These oil palm plantations are thought to be the leading cause of deforestation and a decrease in plant biodiversity in Indonesia. Koh & Wilcove (2008) emphasized that converting land into oil palm plantations harms species diversity.

Tamiang Hulu has a moderate diversity index due to hilly forest environment factors, complex soil structure, and rocky, so edible fruit plants are not found much compared to the other two locations. Waterfalls exist within the TNGL forest area at this location, but rocky soil conditions, soil erosion, and alluvial soils cause minimal soil nutrient content. Plants are inhibited in their growth and development in soil structures like this (Nursanti & Adriadi, 2018).

Evenness Index

The evenness index is the level of abundance of individuals between each species. (Baderan et al., 2021). The evenness index explains the wealth or abundance of individuals between species with the same quantity of individuals, and then the community reaches the maximum evenness value. The evenness value is negligible if the community has minimal evenness. The evenness value (E) ranges from 0-1; if the index value is close to 1, the distribution is even. The evenness of edible fruit plant species in the study site ranged from 0.63 to 0.81. Tenggulun has a value of 0.81, indicating that the evenness of edible fruit plants at this location is high and the community is stable. In contrast, Bandar Pusaka and Tamiang Hulu have an evenness index of 0.63 and 0.72, respectively, indicating that the evenness of edible fruit plants at these locations is moderate with an unstable community.

The high evenness and stable community at the Tenggulun location indicate that the community is stable, so disturbances or other factors disrupt the ecosystem. Initial conditions are not quickly returned to initial conditions due to disturbances to the community. Conversely, Bandar Pusaka and Tamiang Hulu, which have moderate evenness with unstable communities, make it difficult for the community to return to its initial condition when experiencing disturbances and other factors. Serious disturbance prevention is needed to overcome land conversion and massive illegal logging that causes the community to become unstable.

Dominance Index

The dominance index is an assessment describing a centralized species' dominance in the community. This level of dominance can be focused on one species, several species, or various species in the community, which can be identified through a high or low dominance index value (Megawati et al., 2015). The dominance index measures dominance in a location

compared to other species. The higher the dominance index value, the more concentrated the dominance of one plant species. The dominance index is helpful in assessing the extent to which dominating species are distributed within a site. In contrast, if several plant species dominate, the dominance index value will be low, close to 0. No plant species significantly dominates the community if the dominance index value is close to 0.

The dominance of edible fruit plant species showed a low level, with the emergence of dominance values ranging from 0.007-0.009. This value refers to the low dominance category. Low dominance indicates that each species at each location is not dominant, so the distribution of the number of edible fruit plant species dominates. The factor of low dominant plant species is thought to be due to the distribution of plants that are not too wide or the disturbance of illegal logging, which results in a small population of edible fruit plants.

Conclusion

The results of identifying edible fruit plant diversity were 81 species consisting of 27 families. The highest number of species is found in the Tenggulun location (61 species), followed by Bandar Pusaka (53 species) and Tamiang Hulu (44 species). The highest species diversity is at the Tenggulun location with an index value (H') (3.31), Bandar Pusaka (2.88) and finally at the Tamiang Hulu location (2.39), as well as an evenness index (E) ranging from (0.63-0.81) and a dominance index (C) ranging from (0.007-0.009). The many species found in the 3 locations cannot be separated from the threat of species loss in the forest due to lack of public knowledge. This research can be helpful in the community.

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Author Contributions

Conceptualization, A.M, E.S.R, A.R.N.; methodology, A.M, E.S.R, A.R.N.; validation, E.S.R and A.R.N.; formal analysis, A.M.; investigation, A.M.; resources, A.M, E.S.R, A.R.N.; writing—original draft preparation, A.M.; writing—review and editing, E.S.R, A.R.N.; visualization, A.R.N. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The writer aims to publish this article to meet the research output requirement, presenting it in a scientific journal as evidence of the necessary academic achievement. There are no conflicts of interest involved.

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