BIODIVERSITAS
Volume 23, Number 3, March 2022
Pages: 1310-1318

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d230315

Diversity of wild edible fruit plant species and their threatened status in the Aceh Province, Indonesia

ADI BEJO SUWARDI[1,♥], ZIDNI ILMAN NAVIA[2], TISNA HARMAWAN[3], SEPRIANTO[4], SYAMSUARDI[5], ERIZAL MUKHTAR[5]

[1]Department of Biology Education, Faculty of Teacher Training and Education, Universitas Samudra. Jl. Prof. Dr. Syarief Thayeb, Meurandeh, Langsa 24354, Aceh, Indonesia. Tel. +62-641-426535, ♥email: adi.bsw@gmail.com
[2]Department of Biology, Faculty of Engineering, Universitas Samudra. Jl. Prof. Dr. Syarief Thayeb, Meurandeh, Langsa 24354, Aceh, Indonesia
[3]Department of Chemistry, Faculty of Engineering, Universitas Samudra. Jl. Iskandar Muda No. 4-6, Langsa 24354, Aceh, Indonesia
[4]Department of Chemistry Education, Faculty of Teacher Training and Education, Universitas Samudra. Jl. Prof. Dr. Syarief Thayeb, Meurandeh, Langsa 24354, Aceh, Indonesia
[5]Department of Biology, Faculty of Mathematics and Sciences, Universitas Andalas. Jl. Raya Unand, Kampus Limau Manis, Padang 25163, West Sumatra, Indonesia

Manuscript received: 10 January 2022. Revision accepted: 18 February 2022

Abstract. *Suwardi AB, Navia ZI, Harmawan T, Seprianto, Syamsuardi, Mukhtar E. 2022. Diversity of wild edible fruit plant species and their threatened status in the Aceh Province, Indonesia. Biodiversitas 23: 1310-1318.* Aceh Province, Indonesia is home to a diverse range of tropical fruit plants. However, increased anthropogenic activities such as population growth and natural disasters resulted in various biological resources such as wild edible fruit plants being under threat. The study aimed to assess the diversity and threatened status of wild edible fruit plant species in the Aceh Province of Indonesia. The study was conducted in six regencies, namely Aceh Tamiang, Aceh Timur, Aceh Selatan, Aceh Utara, Aceh Barat, and Aceh Tengah. At each study area, a line transect of 1,000 meters was laid from the forest's edge into the forest. Wild edible fruit plant species discovered along the transect were collected and given local names. A total of 129 wild edible fruit plant species at six studied areas in the Aceh Province belonged to 38 families. The highest number of fruit plant species was recorded in the district of Aceh Tamiang, i.e., 63 species, followed by Aceh Selatan (56 species), Aceh Barat (46 species), Aceh Timur (37 species), Aceh Utara (31 species), and Aceh Tengah (23 species). *Mangifera foetida* Lour., *Mangifera odorata* Griff., *Artocarpus integer* (Thunb.) Merr., *Ficus altissima* Blume, *Ficus fistulosa* Reinw. ex Blume, *Syzygium cumini* (L.) Skeels, *Passiflora foetida* L., and *Pometia pinnata* J.R. Forst. & G. Forst. were the most frequently recorded wild fruit plant species in all regencies. From 129 wild edible fruit species recorded in the study areas, 35% are currently classified as Least Concern, 6% as Vulnerable, 3% as Near Threatened, 2% as Low Risk, 2% as Data Deficient, and 52% of species in the IUCN red list had No Available Data. Community-based conservation through domestication of wild edible fruit plant species can be one of the management strategies for the conservation of wild edible fruit plants in Aceh Province.

Keywords: Aceh, biodiversity, fruit, IUCN red list

INTRODUCTION

Wild edible fruit plants are commonly harvested from their natural habitats for human consumption, and they are not cultivated. Humans have consumed wild fruits since immemorial time. They play an important role in the human diet as sources of vitamins, minerals, and dietary fiber (Mahapatra and Panda 2012; Elfrida et al. 2020). Several wild fruits have been reported to be more nutritious than cultivated fruits (Aberoumand and Deokule 2009; Nazarudeen 2010). Wild edible fruits have also been proven to enhance household food security under normal conditions (Broegaard et al. 2017), as well as during crop insufficiency (Erskine et al. 2015) in both rural and urban areas (Clark and Nicholas 2013). Moreover, the wild edible fruit plants have multiple uses such as cosmetics (Gebauer et al. 2016), medicine (Tshikalange et al. 2016; Dreher 2018; Elfrida et al. 2021; Majumder et al. 2021; Navia et al. 2021a; Suwardi et al. 2021), spices or condiments (Navia et al. 2020a), crafts (Atato et al. 2012; Hazarika and Singh 2018), traditional ceremonies (Sutrisno et al. 2020), fiber (Karun et al. 2014), fuel (Debela et al. 2012; Klimas et al. 2012), and even as a substantial income for local communities, particularly those living in remote areas (Deb et al. 2013; Suwardi et al. 2020; Kotresha and Siddeshwari 2021). Several wild fruit trees, such as *Spondias lutea* L., are also used as nesting sites for different types of honey bees, which produce high-quality honey that is harvested and sold by local communities to improve their household income (Jasmi et al. 2014). The fruits have implications for the development of agricultural systems as a source of local food (Navia et al. 2020b; Navia 2021b).

Indonesia is home to over 30,000 species of flowering plants and 226 species of indigenous edible fruit plants (Uji 2007), 184 of which are widely grown wild in tropical forests (Dodo 2015). Sumatra Island is one of the distribution centers of tropical fruits in Indonesia (Uji 2007). As a result, however, increased anthropogenic activities such as population growth and natural disasters may result in various biological resources such as wild edible fruit plants being under threat. According to the Kementerian Lingkungan Hidup dan Kehutanan Republik

Indonesia/Ministry of Environment and Forestry of the Republic of Indonesia (2021), more than 375,000 hectares of Indonesia's forests were deforested in 2018-2019, with Aceh Province accounting for 6,737.5 hectares. In addition to infrastructure development, settlements, agriculture, and mining, the conversion of forest land into monoculture plantations is considered to be the primary driver of the increasing rate of forest deforestation in various regions of Indonesia (Wahyuni and Suranto 2021), including those in Aceh Province. As result, most wild fruits have become vulnerable to extinction. Exploration and promotion of wild edible fruit species, particularly in Aceh Province, is therefore urgently required. Species diversity assessments can provide information on the risks of species extinction, as well as support to determine species protection priorities and develop species conservation strategies (Zhang et al. 2011). The study aims to assess the diversity and threatened status of wild edible fruit plant species in the Indonesian province of Aceh.

MATERIALS AND METHODS

Study area

Aceh Province, Indonesia is located between 01°58'37.2"-06°04'33.6"N and 94°57'57.6"-98°17'13.2"E with average altitude 125 m. The province has a total land area of 57,956 km^2 with forest coverage of 31,556 km^2 or 55% of the total land area. Climatic conditions are tropical humid with annual rainfall varying from 1826 to 4354 mm, and the daily temperature is from 33.6 to 35.6°C (BPS of Aceh Province 2021). Aceh Province is divided into 23 regencies, 289 sub-districts, and 6,464 villages. Six study areas were selected based on their geographic location and forest coverage (Table 1), namely Aceh Tamiang, Aceh Timur, Aceh Selatan, Aceh Utara, Aceh Barat, and Aceh Tengah (Figure 1).

Data collection

The sampling of wild edible fruit plants took place from July 2018 to August 2020. A line transect method was employed. At each study area, a line transect of 1,000 meters was laid from the forest's edge into the forest. Wild edible fruit plant species discovered along the transect were collected and given local names. The botanical name was identified at the Andalas Herbarium of Universitas Andalas, West Sumatra, Indonesia. The botanical names have been updated using The Plants of the World online (http://www.plantsoftheworldonline.org).

Table 1. List of the study area in Aceh Province, Indonesia

Study area	Type	Coordinate
Aceh Tamiang	Lowland dipterocarp	4°16'03.3"N; 97°47'36.7"E
Aceh Timur	Lowland dipterocarp	4°26'18.3"N; 97°24'41.3"E
Aceh Utara	Lowland dipterocarp	4°53'45.3"N; 96°57'00.5"E
Aceh Selatan	Lowland dipterocarp	3°01'58.7"N; 97°28'20.4"E
Aceh Barat	Lowland dipterocarp	4°35'29.9"N; 96°07'14.6"E
Aceh Tengah	Hill dipterocarp	4°18'42.9"N; 97°05'00.5"E

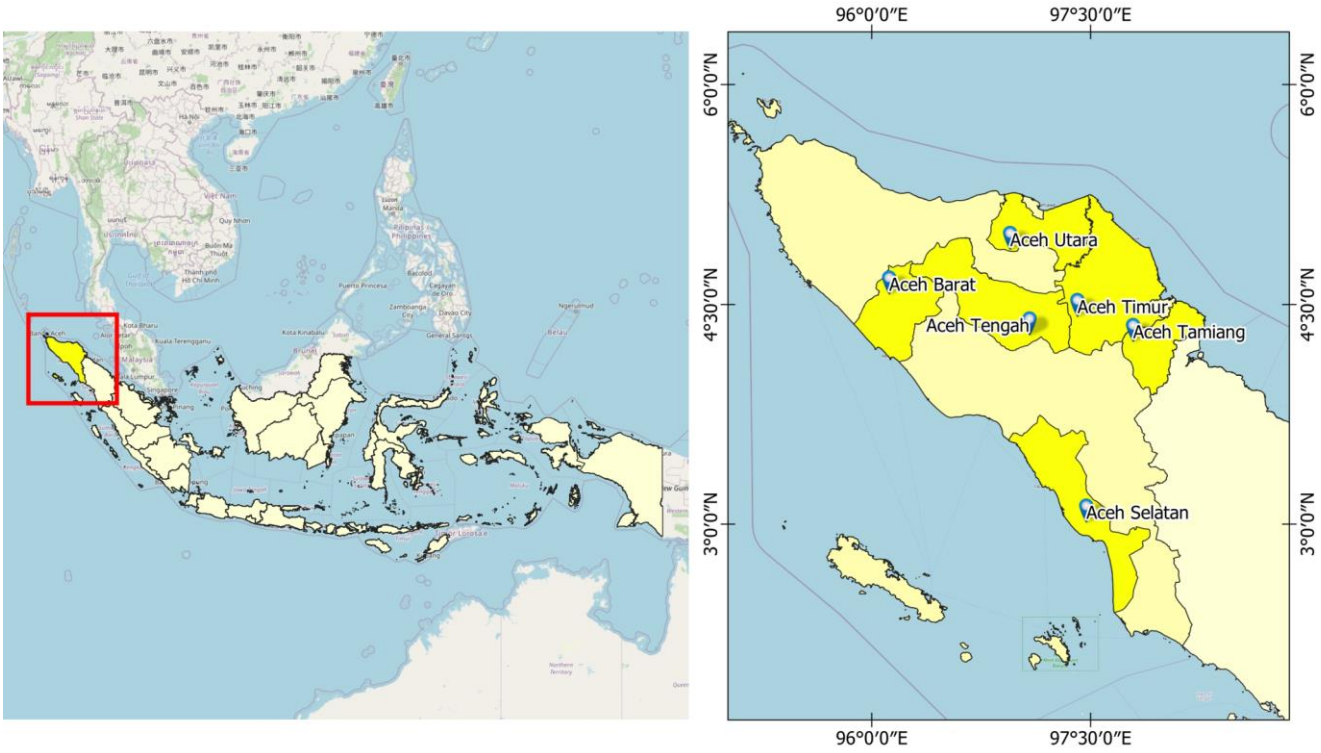

Figure 1. Map of Aceh Province, Indonesia showing the study area

Data analysis

Diversity index

The diversity of wild edible fruit plant species was determined using the Shannon-Wiener Index (H') calculated using the following formula (Barbour et al. 1987):

$$H' = -\sum_{i=1}^{s} Pi \ln Pi$$

Where: H'= Shannon-Wiener Diversity Index, s= number of species, Pi= the proportion of individuals or abundance of the i species expressed as the proportion of the total abundance, ln= natural logarithm of Pi. The diversity index criteria are as follows:

H'≤1 = Low diversity
1 < H'< 3 = Moderate diversity
H'≥3 = High diversity

Evenness index

The evenness index (E) was calculated using the following formula (Magurran 2004):

$$E = \frac{H'}{H_{max}} = \frac{H'}{Ln\ S}$$

Where: E= Evenness, H'= Shannon-Wiener Diversity Index, S= total number of species in the sample, ln= natural logarithm. The evenness index is categorized as follows:

0 < E ≤ 0.5 = Depressed community
0.5 < E ≤ 0.75= Unstable community
0.75 < E ≤1.0 = Stable community

Dominance index

A high uniformity index and low diversity indicate a species' dominance over other species. The dominance index was used in this study with the following formula (Odum 1996):

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

Where: C= Dominance Index, Pi= the proportion of individuals in wild edible fruit species, I= 1, 2…, n
Index values range from 0 to 1 by the following categories:

0 < C < 0.5 = Low Dominance
0.5< C ≤0.75 = Moderate Dominance
0.75< C ≤ 1.0 = High Dominance

Similarity index

To assess the similarities in plant species among the study areas, the Sorenson similarity index was employed using the following formula (Sorenson 1948):

$$QS = \frac{2c}{a+b}$$

Where: QS= Sørensen's similarity coefficient, a= the species numbers in site A; a= the species numbers in site B, and C= the number of species shared by the two sites.

RESULTS AND DISCUSSION

The diversity of wild edible fruit plant species

A total of 129 wild edible fruit plants were recorded from the six study areas, which consisted of 37 families. The highest number of fruit plant species was recorded in the regency of Aceh Tamiang, i.e., 63 species, followed by Aceh Selatan (56 species), Aceh Barat (46 species), Aceh Timur (37 species), Aceh Utara (31 species), and Aceh Tengah (23 species) (Figure 2).

Moraceae and Phyllantaceae were the most represented plant family with 11 species each, followed by Fabaceae and Rosaceae (8 species each), Clusiaceae (7 species), Euphorbiaceae and Myristicaceae (6 species each), and Anacardiaceae, Lauraceae, Malvaceae, Meliaceae, Myrtaceae, and Sapotaceae with 5 species each. The other 14 families possessed 1 to 4 representative species each. *Mangifera foetida* Lour., *Mangifera odorata* Griff., *Artocarpus integer* (Thunb.) Merr., *Ficus altissima* Blume, *Ficus fistulosa* Reinw. ex Blume, *Syzygium cumini* (L.) Skeels, *Passiflora foetida* L., and *Pometia pinnata* J.R. Forst. & G. Forst. were the most frequently recorded wild fruit plant species in all surveyed regencies. On the other hand, 20 wild edible fruit plant species were discovered only in Aceh Tengah regency, 17 species in Aceh Tamiang regency, 16 species in Aceh Selatan regency, and 5 species in Aceh Barat regency (Table 2).

The number of species recorded in this study, i.e., 132 species, is higher than the 86 wild fruit plant species reported in Kerala, India (George and Cristopher 2019), 52 species in Thanh Hoa Province, Northern Vietnam (Nguyen et al. 2021), 30 species in Jharkhand, India (Das 2018), 30 species in Nias, North Sumatra, Indonesia (Ziraluo and Duha 2020), and 36 species in the Benguet, Philippines (Chua-Barcelo 2014). This variation is strongly influenced by the culture and traditional knowledge of the local community. Traditional ecological knowledge of local communities is a critical aspect of biodiversity conservation in a given area (Hanazaki et al. 2018).

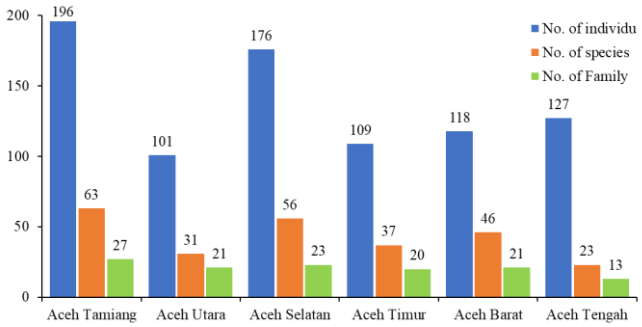

Figure 2. Species composition of wild fruit plants

Table 2. List of wild edible fruit plant species found at each study area

Family	Botanical name	Vernacular name	Study area (regency)						Threat status*
			AT	AU	AS	ATi	AB	ATg	
Anacardiaceae	*Mangifera caesia* Jack.	Binjai	-	-	-	-	+	-	NT
	Mangifera foetida Lour.	Mancang	+	+	+	+	+	-	LC
	Mangifera laurina Blume	Asam pauh	+	+	-	-	+	-	NA
	Mangifera odorata Griff.	Kuweni	+	+	+	+	+	-	DD
	Mangifera quadrifida Jack	Kumbang	-	-	-	-	+	-	LC
Annonaceae	*Monocarpia euneura* Miq.	Not known	-	-	+	-	-	-	VU
	Polyalthia subcordata (Blume) Blume	Not known	-	-	-	-	-	+	NA
	Cyathocalyx sumatranus Scheff	Not known	-	-	-	-	+	-	LC
Apocynaceae	*Leuconotis eugeniifolia* (Wall. ex G.Don) A.DC.	Not known	-	+	-	-	+	-	NA
	Voacanga foetida (Blume) Rolfe	Telur kambing	+	-	+	+	-	-	NA
Araliaceae	*Aralia dasyphylla* Miq	Not known	-	-	-	-	-	+	LC
Arecaceae	*Salacca affinis* Griff.	Salak hutan	-	-	-	+	+	-	NA
Burseraceae	*Santiria laevigata* Blume	Kedondong tunjuk	+	+	-	-	-	-	LC
Clusiaceae	*Garcinia atroviridis* Griff. ex T.Anderson	Asam gelugur	+	+	-	+	-	-	NA
	Garcinia bancana Miq.	Manggis hutan	-	-	-	-	-	+	LC
	Garcinia celebica L.	Manggis hutan	-	-	-	-	-	+	NA
	Garcinia nervosa Miq.	Manggis hutan	+	-	-	-	-	-	NA
	Garcinia nigrolineata Planch. ex T.Anderson	Peralih	+	-	-	-	-	-	NA
	Garcinia parvifolia (Miq.) Miq.	Manggis hutan	-	-	+	-	-	-	NA
	Garcinia xanthochymus Hook.f. ex T.Anderson	Kandis	-	+	+	-	+	-	LC
Ebenaceae	*Diospyros buxifolia* (Blume) Hiern	Not known	+	+	-	+	-	-	NA
	Diospyros macrophylla Bl	Kayu malam	+	-	-	+	-	-	NA
	Diospyros sumatrana Miq.	Kayu arang	+	+	-	+	-	-	DD
Elaeocarpaceae	*Elaeocarpus acronodia* Mast.	Medang	-	-	+	+	-	-	LC
	Elaeocarpus beccarii Aug. DC.	Medang	+	-	+	-	-	-	VU
	Elaeocarpus brigittae Coode	Medang	-	-	+	-	-	-	VU
	Sloanea javanica (Miq.) Koord. & Valeton	Kekarut	-	-	-	-	-	+	LC
Euphorbiaceae	*Blumeodendron tokbrai* (Bl.) Kurz	Bantas	-	-	-	+	+	-	LC
	Bouea macrophylla Griffith	Gandaria	-	-	-	-	+	-	NA
	Cheilosa montana Blume	Not known	+	-	-	-	-	-	LC
	Elateriospermum tapos Blume	Not known	-	-	-	+	-	-	NA
	Homalanthus populneus (Geiseler) Pax	Not known	-	-	-	-	-	+	LC
	Mallotus philippensis (Lam.) Müll.Arg.	Balek angina	+	+	-	-	+	-	LC
Fabaceae	*Archidendron borneense* (Benth.) Kosterm	Jengkol hutan	+	-	-	-	-	-	NA
	Dalbergia pinnata (Lour.) Prain	Peking	-	-	-	-	-	+	LC
	Debregeasia longifolia (Burm.f.) Wedd.	Peking	-	-	-	-	-	+	LC
	Dialium indum L.	Keranji	-	-	-	-	+	-	NA
	Dialium platysepalum Baker	Keranji gunung	-	-	+	-	-	-	NA
	Lithocarpus echinulatus Soepadmo	Gasing	+	-	-	-	+	-	LC
	Lithocarpus indutus (Blume) Rehder	Gasing	+	-	-	+	-	-	VU
	Lithocarpus wallichianus (Lindl. ex Hance) Rehder	Gasing tandauk	-	-	-	+	+	+	NA
Fagaceae	*Castanopsis costata* (Blume) A.DC.	Berangan gunung	+	-	+	-	+	-	NA
Flacourtiaceae	*Flacourtia rukam* Zoll. & Moritzi	Rukam	+	+	+	+	-	+	NA
	Hydnocarpus alpina WT	Not known	-	-	+	-	-	-	NA
Lauraceae	*Actinodaphne cuneata* (Blume) Boerl.	Medang	+	-	-	-	-	-	NA
	Alseodaphne bancana Miq.	Not known	-	-	-	-	-	+	LC
	Cryptocarya nigra Kosterm.	Not known	-	-	-	-	-	+	VU
	Endriandra rubescens (Blume) Miq.	Not known	-	-	-	-	-	+	NA
	Phobe grandis (Nees) Merr.	Medang nangka	-	-	-	-	-	+	NA
Lecythidaceae	*Planchonia vallida* BI	Not known	-	+	-	+	+	-	NA
Leeaceae	*Leea rubra* Blume ex Spreng.	Not known	-	-	+	-	-	-	NA
Leguminosae	*Archidendron borneense* (Benth.) I.C. Nielsen	Jengkol hutan	+	+	-	-	-	-	NA
Lythraceae	*Lagerstroemia ovalifolia* Teijsm & Binn	Bungur	+	-	+	-	+	-	NA

Malvaceae	*Boschia griffithii Mast.*	Durian enggang	+	-	-	-	+	-	VU
	Durio conatus Priyanti	Durian merah	+	-	-	-	-	-	NA
	Durio lowianus Scort. ex King	Durian merah	-	-	-	+	-	-	VU
	Durio oxleyanus Griff.	Durian daun	-	-	+	+	+	-	NT
	Microcos latistipulata (Ridl.) Burret	Not known	+	-	-	-	-	-	NA
Meliaceae	*Aglaia tomentosa* Teijsm. &Binn.	Not known	+	-	-	-	-	-	LC
	Chisocheton patens Blume	Not known	+	-	-	-	-	-	NA
	Dysoxylum alliaceum (Blume) Blume	Not known	+	-	-	-	-	-	LC
	Dysoxylum cyrtobotryum Miq.	Not known	+	-	-	-	-	-	LC
	Sandoricum koetjape (Burm.f.) Merr.	Setui	+	-	-	+	-	-	LC
Moraceae	*Artocarpus rigidus* Blume	Terap	+	-	-	+	-	-	NA
	Artocarpus integer (Thunb.) Merr.	Cempedak	+	+	+	+	+	-	NA
	Artocarpus elasticus Reinw. ex Blume	Terap	+	-	+	-	-	-	LC
	Artocarpus gomezianus Wall. ex Trécul	Terap gunung	-	-	+	-	-	-	NA
	Morus alba L	Murbei gunung	-	-	-	-	-	+	NA
	Ficus altissima Blume	Ara	+	+	+	+	+	-	LC
	Ficus fistulosa Reinw. ex Blume	Ara	+	+	+	+	+	-	LC
	Ficus globosa Blume	Ara	+	-	+	-	+	-	NA
	Ficus lepicarpa Blume	Ara	+	-	+	-	+	-	LC
	Ficus racemosa L.	Ara	+	-	+	+	+	-	LC
	Ficus virens Aiton	Ara	+	-	-	+	-	-	LC
Musaceae	*Musa balbisiana* Colla	Pisang hutan	-	+	-	-	-	-	LC
	Musa textilis Née	Pisang hutan	-	+	-	+	-	-	NA
Myristicaceae	*Knema cinerea* (Poir.) Warb.	Dedarah	-	-	+	-	-	-	NA
	Knema furfuracea (Hook f. & Thomson) Warb	Dedarah	-	-	+	-	-	-	LC
	Knema latericia Elmer	Dedarah	+	-	+	-	+	-	LC
	Knema losirensis W.J.de Wilde	Dedarah	+	+	-	-	-	-	LR
	Myristica schifferii Warb	Pala hutan	-	-	+	-	-	-	NA
	Myristica elliptica Wall	Pala hutan	-	-	+	-	-	-	LC
Myrtaceae	*Decaspermum montanum* Ridl.	Not known	-	-	-	-	-	+	NA
	Syzygium cerasiforme (Blume) Merr. & L.M.Perry	Jambu hutan	+	+	+	-	-	-	NA
	Syzygium cumini (L.) Skeels	Jambu keling	+	+	+	+	+	-	LC
	Syzygium polyanthum (Wight) Walp	Salam	+	+	+	+	-	-	NA
	Syzygium pycnanthum Merr. & L.M.Perry.	Jambu hutan	-	-	+	-	+	-	NA
Oxalidaceae	*Sarcotheca diversifolia* (Miq.) Hallier f.	Not known	-	-	+	-	+	-	NA
Passifloraceae	*Adenia grandifolia* Ridl	Not known	+	-	+	-	+	-	LC
	Passiflora foetida L.	Rambusa	+	+	+	+	+	-	NA
Phyllanthaceae	*Aporosa benthamiana* Hook.f.	Kayu asam	+	-	-	-	-	-	NA
	Baccaurea bracteata Müll.Arg.	Tampoi	-	+	-	+	+	-	NA
	Baccaurea brevipes Hook.f.	Tampoi hutan	-	-	+	-	+	-	NA
	Baccaurea macrophylla (Mull. Arg) Mull. Arg	Tampoi	+	-	+	+	+	-	NA
	Baccaurea costulata (Miq) Mull. Arg	Tampoi	+	+	+	-	-	-	VU
	Baccaurea lanceolata (Miq.) Mull.Arg	Kepong	+	-	+	+	-	-	NA
	Baccaurea macrocarpa (Miq.) Müll.Arg.	Tampoi	+	-	+	+	+	-	NA
	Baccaurea polyneura Hook.f.	Jentik	-	-	+	+	-	-	LR
	Baccaurea pyriformis Gage	Tampoi	-	-	+	-	+	-	LC
	Baccaurea racemosa (Reinw. ex Blume) Müll. Arg	Tampoi/menteng	+	-	+	+	-	-	NA
	Baccaurea sumatrana (Miq.) Müll.Arg.	Tampoi	-	-	+	-	-	-	NA
Proteaceae	*Helicia robusta* (Roxb.) R.Br. ex Blume	Not known	+	+	-	-	-	-	LC
Rhamnaceae	*Ziziphus calophylla* Wall.	Jonong	-	-	+	-	-	-	NA
	Ziziphus horsfieldii Miq.	Jonong	-	+	-	-	+	-	NA
Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl	Biwa gunung	-	-	-	-	-	+	NA
	Prunus arborea (Blume) Kalkman	Ceri	+	-	-	+	-	+	LC
	Prunus grisea (Blume ex Müll.Berol.) Kalkman	Ceri	-	-	+	-	+	-	LC
	Rubus alceifolius Poir.	Beri hutan	+	+	+	-	+	-	NA
	*Rubus calycinus*Wall ex. D. Don	Beri	-	-	-	-	-	+	NA
	Rubus moluccanus L.	Beri	+	-	+	-	+	-	NA
	Rubus pyrifolius Hook.f. & Thomson ex.Hook.f.	Beri	-	-	-	-	-	+	NA
	Rubus rosifolius Sm.	Beri hutan	-	-	-	-	-	+	NA
Rubiaceae	*Anthocephalus cadamba* Miq.	Not known	+	-	-	-	-	-	NA

Rutaceae	*Acronychia pedunculata* (L.) Miq.	Not known	-	-	-	-	-	+	LC
	Limonia acidissima L.	Batok	-	+	-	-	-	-	NA
	Melicope hookeri T.G.Hartley	Not known	-	-	-	-	-	+	LC
	Micromelum minutum (G.Forst.) Wight & Arn.	Canggai	-	-	+	+	-	-	LC
Sapindaceae	*Lepisanthes fruticosa* (Roxb.) Leenh.	Rambutan biabak	+	-	-	-	-	-	LC
	Nephelium cuspidatum Blume	Rambutan hutan	+	-	-	-	-	-	LC
	Pometia pinnata J.R. Forst. & G. Forst.	Matoa hutan	+	+	+	+	+	-	LC
	Xerospermum noronhianum (Blume) Blume	Rambutan hutan	-	-	+	-	-	-	NA
Sapotaceae	*Diploknema oligomera* H.J.Lam	Punti	-	+	+	-	+	-	NA
	Palaquium gutta (Hook) Baill	Not known	-	-	+	-	-	-	NT
	Payena lucida A.DC.	Not known	-	-	-	-	+	-	NT
	Planchonella duclitan (Blanco) Bakh.f.	Not known	-	-	+	-	+	-	LC
	Pleioluma firma (Miq.) Swenson	Not known	+	-	-	-	+	-	LC
Staphyleaceae	*Dalrympelea sphaerocarpa* (Hassk.) Nor-Ezzaw.	Not known	+	-	-	-	-	-	NA
Violaceae	*Rinorea sclerocarpa* (Burgersd.) Melch.	Not known	-	-	+	-	-	-	NA
Vitaceae	*Causonis trifolia* (L.) Mabb. & J.Wen	Anggur hutan	+	-	-	-	-	-	NA

Note: Regencies: AT: Aceh Tamiang; AU: Aceh Utara; AS: Aceh Selatan; ATi: Aceh Timur; AB: Aceh Barat; ATg: Aceh Tengah; Threat Status: NA: Not Available; DD: Data Deficient; LC: Least Concern; NT: Near Threatened; LR: Lower Risk; VU: Vulnerable; -: absent; +: present; *: IUCN Red List of Threatened Species

The findings of the species diversity analysis at the studied area revealed that the value of the species diversity index (H') ranged between 2.78 and 3.85 (Table 3). This indicates that the fruit plant species diversity index in the study area is high (Kent and Paddy 1992). The diversity of wild edible fruit plant species was higher in Aceh Tamiang (3.85), but lower in Aceh Tengah (2.78). The high diversity index in Aceh Tamiang is caused by the fact that the number of species and population is greater than in other study areas. This finding is comparable to the study reported by Solikin (2019), who noticed that the number of species and populations is positively correlated with the diversity index value. Low species diversity noted in Aceh Tengah (H'= 2.78) could be explained by the fact that it is dominated by only two species, *Garcinia celebica* L., and *Garcinia bancana* Miq. These species were accounted for 22% and 14% of the total number of wild edible fruit plants in the area, respectively. Furthermore, the dominance of wild edible fruit plant species in the study area ranged from 0.03 to 0.09, indicating a low level of dominance, and the population of each plant species is more evenly distributed.

In the six study areas, the evenness index ranged from 0.88 to 0.96 (Table 4). Aceh Barat regency had a higher evenness index value (0.96), indicating that the ecosystem in the area is more stable. On the other hand, the evenness index in the Aceh Tengah regency was the lowest, indicating that the community's stability and diversity of plant species are at the lowest (Odum 1996).

Comparison of species diversity among regencies

Species similarity among all regencies compared is expressed by the Sorenson similarity index. The result of the species diversity comparison is shown in Table 4.

Similarity index among vegetation transects demonstrates a strong variation on local scales. Similarity values ranged from 0.05 to 1.22 (Table 4). It is observed that the similarity is very high, with a coefficient of similarity greater than 100%, for Aceh Tengah–Aceh Barat (122%). This result is not surprising because the forest habitat in these areas is comparable to both topography and forest structure. Low similarities were detected for Aceh Selatan–Aceh Tengah and Aceh Timur–Aceh Tengah (3% each). The study area in Aceh Tengah is a dipterocarp highland forest, whereas the areas in Aceh Timur and Aceh Selatan are dominantly lowland dipterocarp forests, with differences in altitude, climatic, and soil types affecting the forest's vegetation structure. Topographical factors (e.g., altitude, aspect, and slope) and edaphic factors (soil type, soil fertility, and texture) may influence vegetation growth (Neri et al. 2016; Ramos et al. 2020) and play an important role in plant species distribution (Bhat et al. 2020), which lead to species diversification (Bhardwaj 2021) and could guide forest composition at one altitude (Kumar et al. 2021).

Threaten status of wild edible fruit plants

Land-use changes (e.g., conversion to agriculture, changes in agricultural practices, and infrastructure development), habitat destruction (due to timber harvesting, fuelwood collection, grazing, and forest fires), and overharvesting are all threats to wild edible fruit plants that grow both inside and outside protected areas. We used data from the International Union for Conservation of Nature (IUCN) Red List Index for Plants (2021) to determine that of 129 wild edible fruit species, 35% are currently classified as Least Concern, 6% as Vulnerable, 3% as Near Threatened, 2% as Low Risk, 2% as Data Data Deficient, and 52% have No Available Data (Figure 3).

Table 3. The dominance, Shannon diversity, and evenness indexes of six regencies in the study area

District	No. of species	Shannon-Diversity Index (H')	Dominance Index (C)	Evenness Index (E)
Aceh Tamiang	63	3.85	0.03	0.92
Aceh Utara	31	3.25	0.05	0.95
Aceh Selatan	56	3.84	0.03	0.95
Aceh Timur	37	3.40	0.04	0.94
Aceh Barat	46	3.68	0.03	0.96
Aceh Tengah	23	2.78	0.09	0.88

Table 4. Sorenson similarity index

	Aceh Tamiang	Aceh Utara	Aceh Timur	Aceh Selatan	Aceh Barat	Aceh Tengah
Aceh Tamiang		0.88	0.96	0.90	0.75	0.05
Aceh Utara			0.86	0.46	0.79	0.04
Aceh Timur				0.75	0.63	0.11
Aceh Selatan					**1.22**	0.03
Aceh Barat						0.03
Aceh Tengah						

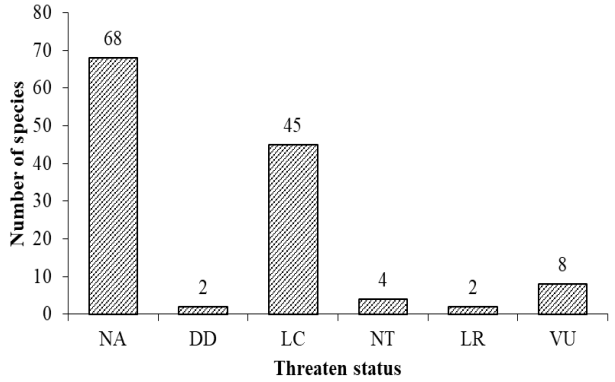

Figure 3. Number of WEFs on the IUCN Red List of Threatened Species (2021) classified by class and risk category. NA: Not Available; DD: Data Deficient; LC: Least Concern; NT: Near Threatened; LR: Lower Risk; VU: Vulnerable

Monocarpia euneura Miq., *Elaeocarpus beccarii* Aug. DC., *Elaeocarpus brigittae* Coode, *Lithocarpus indutus* (Blume) Rehder, *Cryptocarya nigra* Kosterm., *Boschia griffithii* Mast., *Durio lowianus* Scort. ex King, and *Baccaurea costulata* (Miq) Mull. Arg were the eight wild edible fruit plant species listed as Vulnerable. Moreover, *Baccaurea polyneura* Hook.f. and *Knema losirensis* W.J.de Wilde were classified as Low Risk. The IUCN red list, however, has not yet listed the threatened status of more than half of the wild edible fruit plant species found in this study. Borelli et al. (2020) discovered that only one-third (31%) of known wild fruit plant species have global conservation assessments in the IUCN Red List Index for Plants.

Management of wild edible fruit plant species

The socio-ecological impacts of harvesting wild edible fruit plants are influenced by interactions between harvested species and their ecosystems, as well as co-occurring land uses in the extraction landscape (Sardeshpande and Shackleton 2019). Co-management strategies such as community-based conservation (CBC) and joint forest management (JFM) can reduce unsustainable harvesting of wild edible fruit, improve household food security (Pailler et al. 2015), and income (Bauch et al. 2014). Community-based conservation through domestication of wild edible fruit plant species can be one of the management strategies for the conservation of wild edible fruit plants, as well as to have the potential to improve rural communities' household income in Aceh Province, particularly in remote areas. Aceh Province gains an opportunity to advance a variety of agricultural products, including wild edible fruits. The availability of land and a suitable climate encourages the survival of various tropical fruit species in this area. Ex-situ conservation can be accomplished by domesticating wild edible fruit plant species using the agroforestry concept. Local communities can grow indigenous edible fruit by combining them with crops in their orchards, home gardens, or farmland. The selection, management, and cultivation of wild edible fruit plant species may necessitate the application of both silvicultural and horticultural concepts (Akinnifesi et al. 2007). Small-scale farmer training in nursery management, on-farm management, harvesting, post-harvest management, and marketing of plant products can be considered to ensure the sustainability of wild edible fruit plant species. Educational efforts for the community, on the other hand, are required to emphasize the importance of consuming wild edible fruit plant species for health. Furthermore, serving wild edible fruit plant species, for example, on all government-organized activities can be a form of government support in the campaign to consume wild edible fruits. Promoting and domesticating wild edible fruit plant species can improve the nutritional status and livelihoods of local communities as well as protect these fruit species from extinction in the wild (Rathore 2009).

ACKNOWLEDGEMENTS

We are grateful to all people in the studied villages for their kind hospitality and sharing knowledge. We also are grateful to the Indonesian Ministry of Research, Technology and Higher Education for the Collaborative Research Grant in 2018-2019 and Universitas Samudra for the Basic Research Grant in 2020.

REFERENCES

Aberoumand A, Deokule SS. 2009. Studies on nutritional values of some wild edible plants from Iran and India. Pak J Nutr 8 (1): 26-31. DOI: 10.3923/pjn.2009.26.31.

Akinnifesi FK, Leakey RRB, Ajayi OC, Sileshi G, Tchoundjeu Z, Matakala P, Kwesiga F. 2007. Indigenous Fruit Trees in the Tropics: Domestication, Utilization and Commercialization. CAB International, Wallingford. DOI: 10.1079/9781845931100.0000.

Atato A, Wala K, Dourma M, Bellefontaine R, Woegan YA, Batawila K, Akpagana K. 2012. Espèces lianescentes à fruits comestibles du Togo. Fruits 67: 353-368. DOI: 10.1051/fruits/2012030.

Badan Pusat Statistik (BPS) of Aceh Province. 2021. Aceh Province in Figure 2020. BPS of Aceh Province, Aceh. [Indonesian]

Barbour GM, Burk JK, Pitts WD. 1987. Terrestrial Plant Ecology. The Benyamin /Cummings Publishing Company, New York.

Bauch SC, Sills EO, Pattanayak SK. 2014. Have we managed to integrate conservation and development? ICDP impacts in the Brazilian Amazon. World Dev 64: 135-148. DOI: 10.1016/j.worlddev.2014.03.009.

Bhardwaj DR, Tahiry H, Sharma P, Pala NA, Kumar D, Kumar A, Bharti. 2021. Influence of aspect and elevational gradient on vegetation pattern, tree characteristics and ecosystem carbon density in Northwestern Himalayas. Land 10: 1109. DOI: 10.3390/land10111109.

Bhat JA, Kumar M, Negi A, Todaria N, Malik ZA, Pala NA, Kumar A, Shukla G. 2020. Altitudinal gradient of species diversity and community of woody vegetation along altitudinal gradient of the Western Himalayas. Glob Ecol Conserv 24: e01302. DOI: 10.1016/j.gecco.2020.e01302.

Borelli T, Hunter D, Powell B, Ulian T, Mattana E, Termote C, Pawera L, Beltrame D, Penafiel D, Tan A, Taylor M, Engels J. 2020. Born to eat wild: An integrated conservation approach to secure wild food plants for food security and nutrition. Plants 9: 1299. DOI: 10.3390/plants9101299.

Broegaard RB, Rasmussen LV, Dawson N, Vongvisouk T, Grogan K. 2017. Wild food collection and nutrition under commercial agriculture expansion in agriculture-forest landscapes. For Policy Econ 84: 92-101. DOI: 10.1016/j.forpol.2016.12.012.

Chua-Barcelo RC. 2014. Ethno-botanical survey of edible wild fruits in Benguet, Cordillera administrative region, the Philippines. Asian Pac J Trop Biomed 4 (Suppl 1): S525-S538. DOI: 10.12980/APJTB.4.201414B36.

Clark KH, Nicholas KA. 2013. Introducing urban food forestry: A multifunctional approach to increase food security and provide ecosystem services. Landsc Ecol 28: 1649-1669. DOI: 10.1007/s10980-013-9903-z.

Das A. 2018. Ethnobotanical uses of wild fruits of Santal Paraganas (Jharkhand). Intl J Minor Fruits Med Aromatic Plants 4 (2): 31-38.

Deb CR, Jamir NS, Ozukum S. 2013. A study on the survey and documentation of underutilized crops of three district of Nagaland, India. Glob J Biosci 2: 67-70.

Debela HF, Njoka JT, Asfaw Z, Nyangito MM. 2012. Nutritional value of Berchemia discolor: A potential to food and nutrition security of households. J Biol Sci 12: 263-271. DOI: 10.3923/jbs.2012.263.271.

Dodo. 2015. Keanekaragaman dan konservasi tumbuhan langka Indonesia. Warta Kebun Raya 13 (2): 37-42. [Indonesian]

Dreher ML. 2018. Whole fruits and fruit fiber emerging health effects. Nutrients 10: 1833. DOI: 10.3390/nu10121833.

Elfrida, Mubarak A, Suwardi AB. 2020. The fruit plant species diversity in the home gardens and their contribution to the livelihood of communities in rural area. Biodiversitas 21 (8): 3670-3675. DOI: 10.13057/biodiv/d210833.

Elfrida E, Tarigan NS, Suwardi AB. 2021. Ethnobotanical study of medicinal plants used by community in Jambur Labu Village, East Aceh, Indonesia. Biodiversitas 22 (7): 2893-900. DOI: 10.13057/biodiv/d220741.

Erskine W, Ximenes A, Glazebrook D, da Costa M, Lopes M, Spyckerelle L, Williams R, Nesbitt H. 2015. The role of wild foods in food security: The example of Timor-Leste. Food Sec 7: 55-65. DOI: 10.1007. DOI: 10.1007/s12571-014-0406-9.

Gebauer J, Adam YO, Sanchez AC, Darr D, Eltahir ME, Fadl KE, Hunsche M. 2016. Africa's wooden elephant: The baobab tree (*Adansonia digitata* L.) in Sudan and Kenya: A review. Genet Resour Crop Evol 63: 377-399. DOI: 10.1007/s10722-015-0360-1.

George MV, Christopher G. 2019. Structure, diversity and utilization of plant species in tribal homegardens of Kerala, India. Agrofor Syst 94: 297-307. DOI: 10.1007/s10457-019-00393-5.

Hanazaki N, Zank S, Fonseca-Kruel VS, Schmidt IB. 2018. Indigenous and traditional knowledge, sustainable harvest, and the long road ahead to reach the 2020 Global Strategy for Plant Conservation objectives. Rodriguésia 69 (4): 1587-1601. DOI: 10.1590/2175-7860201869409.

Hazarika TK, Singh TS. 2018. Wild edible fruits of Manipur, India: Associated traditional knowledge and implications to sustainable livelihood. Genet Resour Crop Evol 65: 319-332. DOI: 10.1007/s10722-017-0534-0.

Jasmi, Salmah S, Dahelmi, Syamsuardi. 2014. Nesting sites of *Apis cerana* Fabr. (Hymenoptera: Apidae) in two different altitutes of polyculture plantations in West Sumatera. Hayati 21 (3): 135-143. DOI: 10.4308/hjb.21.3.135.

Karun NC, Vaast P, Kushalappa CG. 2014. Bioinventory and documentation of traditional ecological knowledge of wild edible fruits of Kodagu-Western Ghats, India. J For Res 25: 717-721. DOI: 10.1007/s11676-014-0513-7.

Kementerian Lingkungan Hidup dan Kehutanan. 2021. Deforestasi Indonesia Tahun 2019-2020. Direkorat Inventarisasi dan Pemantauan Sumber Daya Hutan. Direktorat Jenderal Planologi Kehutanan dan Tata Lingkungan. Kementerian Lingkungan Hidup dan Kehutanan, Jakarta. [Indonesian]

Kent M, Paddy C. 1992. Vegetation Description and Analysis a Practical Approach. Belhaven Press, London.

Klimas CA, Kainer KA, de Oliveira Wadt LH. 2012. The economic value of sustainable seed and timber harvests of multi-use species: An example using *Carapa guianensis*. For Ecol Manag 268: 81-91. DOI: 10.1016/j.foreco.2011.03.006.

Kotresha K, Siddeshwari M. 2021. Wild edible fruits and their medicinal uses in Ballari District of Karnataka. PENSEE 51 (6): 1136-1143.

Kumar A, Pinto MC, Candeias C, Dinis PA. 2021. Baseline maps of potentially toxic elements in the soils of Garhwal Himalayas, India: Assessment of their eco-environmental and human health risks. Land Degrad Dev 32: 3856-3869. DOI: 10.1002/ldr.3984.

Magurran A. 2004. Measuring Biological Diversity. Blackwell Publishing, Oxford, UK.

Mahapatra AK, Panda PC. 2012. Wild edible fruit diversity and its significance in the livelihood of indigenous tribals: Evidence from Eastern India. Food Sec 4: 219-234. DOI: 10.1007/s12571-012-0186-z.

Majumder S, Acharyya S, Ghosh A, Chakraborty S, Sarkar S, Saha S, Bhattacharya M. 2021. Insights into low biological activity of wax apple (*Syzygium samarangense*) juice by in vitro phytochemical investigation with special reference to metabolomics. Biofarmasi J Nat Prod Biochem 19: 30-38. DOI: 10.13057/biofar/f190106.

Navia ZI, Audira D, Afifah N, Turnip K, Nuraini, Suwardi AB. 2020a. Ethnobotanical investigation of spice and condiment plants used by the Taming Tribe in Aceh, Indonesia. Biodiversitas 21 (10): 4467-4473. DOI: 10.13057/biodiv/d211001.

Navia ZI, Suwardi AB, Harmawan T, Syamsuardi, Mukhtar E. 2020b. The diversity and contribution of indigenous edible fruit plants to the rural community in the Gayo Highlands, Indonesia. J Agric Rural Dev Trop Subtrop 121 (1): 89-98.

Navia ZI, Suwardi AB, Baihaqi. 2021a. Ethnobotanical study of medicinal plants used by local communities in Sekerak Sub-district, Aceh Tamiang, Indonesia. Biodiversitas 22 (10): 4467-4473. DOI: 10.13057/biodiv/d221019.

Navia ZI, Suwardi AB, Nuraini. 2021b. The importance of tropical edible fruit plants for tribal communities in East Aceh Region, Indonesia. Earth Environ Sci 637: 012003. DOI: 10.1088/1755-1315/637/1/012003.

Nazarudeen A. 2010. Nutritional composition of some lesser-known fruits used by ethnic communities and local folks of Kerela. Ind J Tradit Knowl 9 (2): 398-402.

Neri AV, Borges GRA, Meira-Neto JAA, Magnago LFS, Trotter IM, Schaefer CEG, Porembski S. 2016. Soil and altitude drive diversity and functioning of Brazilian Páramos (campo de altitude). J Plant Ecol 16: 1-9. DOI: 10.1093/jpe/rtw088.

Nguyen CH, Averyanov L, Egorov A, Nguyen CV, Tran TT. 2021. Edible wild plants in the flora of Pu Luong Nature Reserve, Thanh Hoa Province, Northern Vietnam. Earth Environ Sci 876: 012054. DOI: 10.1088/1755-1315/876/1/012054.

Odum EP. 1996. Dasar-Dasar Ekologi. Edisi ketiga. Gajah Mada Universitas Press, Yogyakarta. [Indonesian]

Pailler S, Naidoo R, Burgess ND, Freeman OE, Fisher B. 2015. Impacts of community-based natural resource management on wealth, food security and child health in Tanzania. PLoS ONE 10: e0133252. DOI: 10.1371/journal.pone.0133252.

Ramos MB, Diniz FC, de Almeida HA, de Almeida GR, Pinto AS, Meave JA, Lopes SF. 2020. The role of edaphic factors on plant species richness and diversity along altitudinal gradients in the Brazilian semi-arid region. J Trop Ecol 36 (5): 1-14. DOI: 10.1017/S0266467420000115.

Rathore M. 2009. Nutrient content of important fruit trees from arid zone of Rajasthan. J Hort For 1: 1103-1109.

Sardeshpande M, Shackleton C. 2019. Wild edible fruits: A systematic review of an under-researched multifunctional NTFP (Non-Timber Forest Product). Forests 10: 467. DOI: 10.3390/f10060467.

Solikin. 2019. Plants diversity and similarity in three sites growing area of *Stachytarpheta jamaicensis* (L.) Vahl. AIP Conf Proc 2120: 030011. DOI: 10.1063/1.5115615.

Sorenson TA. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content, and its application to analyses of the vegetation on Danish commons. Det Kongelige Danske Videnskabernes Selskab Biologiske Skrifter 5: 1-34.

Sutrisno IH, Akob B, Navia ZI, Nuraini, Suwardi AB. 2020. Documentation of ritual plants used among the Aceh Tribe in Peureulak, East Aceh District, Indonesia. Biodiversitas 21 (11): 4990-4998. DOI: 10.13057/biodiv/d211102.

Suwardi AB, Navia ZI, Harmawan T, Syamsuardi, Mukhtar E. 2020. Wild edible fruits generate substantial income for local people of the Gunung Leuser National Park, Aceh Tamiang Region. Ethnobot Res Appl 20: 11. DOI: 10.32859/era.20.11.1-13.

Suwardi AB, Mardudi, Navia ZI, Baihaqi, Muntaha. 2021. Documentation of medicinal plants used by Aneuk Jamee Tribe in Kota Bahagia Sub-district, South Aceh, Indonesia. Biodiversitas 22 (1): 6-15. DOI: 10.13057/biodiv/d220102.

Tshikalange TE, Mophuting BC, Mahore J, Winterboer S, Lall N. 2016. An ethnobotanical study of medicinal plants used in villages under Jongilanga tribal council, Mpumalanga, South Africa. Afr J Tradit Compl Altern Med 13 (6): 83-89. DOI: 10.21010/ajtcam.v13i6.13.

Uji T. 2007. Review. Keanekaragaman jenis buah-buahan asli Indonesia dan potensinya. Biodiversitas 8 (2): 157-167.

Wahyuni H, Suranto. 2021. Dampak deforestasi hutan skala besar terhadap pemanasan global di Indonesia. J Ilmiah Ilmu Pemerintahan 6 (1): 148-162. DOI: 10.14710/jiip.v6i1.10083. [Indonesian]

Zhang Y, Yuan H, Yu M. 2011. Assessment of threaten status on the wild plants under state protection in China. Biodivers Sci 19 (1): 57062. DOI: 10.3724/SP.J.1003.2011.06133.

Ziraluo YPB, Duha M. 2020. Diversity study of fruit producer plant in Nias Islands. J Inovasi Penelitian 1 (4): 683-694. [Indonesian]