



The diversity and traditional knowledge of wild edible fruits in Bengkulu, Indonesia

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Research

Abstract

Background: Wild edible fruit plant species (WEFs) contribute significantly to human well-being. These plants have a high nutritional value and are a source of novel alleles/genes that are important in developing new and improved crop cultivars to promote sustainable food security. However, most WEFs are less well-known and underutilized. This study aimed to investigate wild edible fruit species diversity and their potential in the Bengkulu region, Indonesia.

Methods: The ethnobotanical study was carried out in eight villages from four districts of Bengkulu province, Indonesia, i.e. Mukomuko, Lebong, Rejang Lebong, and Bengkulu Selatan. The ethnobotanical survey was carried out from July to September 2022 and included 383 randomly selected respondents. The ethnobotanical investigation uses semi-structured questionnaires to gather information on the traditional knowledge of WEFs. Plant specimens were collected and identified in herbarium ANDA, Universitas Andalas.

Results: A total of 73 wild edible fruit plant species belonging to 37 genera and 26 families were recorded in the study area. Most of the plant species were trees (87.7%), followed by shrubs (5.5%), climbers (4.1%), and herbs (2.7%). Forty-eight (79.5%) species were discovered in the forest, 7 (9.6%) in the farmlands, and 8 (11%) in both the forest and the farmlands. WEFs are mostly consumed as food. *Artocarpus integer*, *Mangifera odorata*, *Pometia pinnata*, *Flacourtia rukam*, *Durio oxleyanus*, *Baccaurea racemosa*, *Bellucia pentamera*, *Baccaurea macrocarpa*, *Baccaurea polyneura*, and *Mangifera foetida*. *Artocarpus integer* are the most preferred WEFs by their taste quality. Besides foods, WEFs have multi purposes including as traditional medicine, construction, agricultural tools, fuelwood, and fodder. Indigenous knowledge of WEFs was significantly associated with districts, age groups, and educational levels.

Conclusion: Bengkulu has a diverse range of WEFs, but only a small proportion has been used by local people, particularly as food. Promotion and domestication of WEFs should be a primary concern in Bengkulu in order to take advantage of their nutritional value and potential economic value. Moreover, integrating knowledge related to WEFs into the educational curriculum is critical for educating the next generation regarding the potential of WEFs in the future.

Keywords: Bengkulu, biodiversity, local knowledge, wild fruits, underutilized plants

Abstrak

Latar Belakang: Tumbuhan buah-buahan liar yang dapat dimakan berperan penting dalam meningkatkan kesejahteraan hidup manusia. Tumbuhan ini memiliki nilai gizi yang tinggi dan merupakan sumber alel/gen baru yang penting dalam mengembangkan kultivar tanaman baru dan lebih baik untuk mempromosikan ketahanan pangan berkelanjutan. Namun, sebagian besar tumbuhan buah-buahan liar ini kurang dikenal dan kurang dimanfaatkan. Penelitian ini bertujuan untuk mengetahui keanekaragaman jenis buah-buahan liar yang dapat dimakan dan potensinya di wilayah Bengkulu, Indonesia.

Metode: Studi etnobotani dilakukan pada delapan desa dari empat kabupaten di Provinsi Bengkulu, Indonesia, yaitu Mukomuko, Lebong, Rejang Lebong, dan Bengkulu Selatan. Survei etnobotani dilakukan dari Juli hingga September 2022 dengan melibatkan 383 responden yang dipilih secara acak. Penelitian etnobotani menggunakan kuesioner semi-terstruktur untuk mengumpulkan informasi tentang pengetahuan tradisional terhadap tumbuhan buah-buahan liar. Spesimen tumbuhan dikumpulkan dan diidentifikasi di herbarium ANDA, Universitas Andalas.

Hasil: Sebanyak 73 jenis tumbuhan buah-buahan liar yang termasuk dalam 37 marga dan 26 suku telah ditemukan di lokasi penelitian. Jenis tumbuhan terbanyak berupa pohon (87,7%), diikuti oleh perdu (5,5%), pemanjat (4,1%), dan herba (2,7%). Empat puluh delapan (79,5%) jenis ditemukan di hutan, 7 (9,6%) di lahan pertanian, dan 8 (11%) di hutan dan lahan pertanian. Tumbuhan buah-buahan liar sebagian besar dikonsumsi sebagai makanan. *Artocarpus integer*, *Mangifera odorata*, *Pometia pinnata*, *Flacourtia rukam*, *Durio oxleyanus*, *Baccaurea racemosa*, *Bellucia pentamera*, *Baccaurea macrocarpa*, *Baccaurea polyneura*, dan *Mangifera foetida* merupakan jenis yang paling disukai berdasarkan kualitas rasanya. Selain dimanfaatkan sebagai makanan, tumbuhan buah-buahan liar juga memiliki banyak kegunaan, antara lain sebagai obat tradisional, bahan bangunan, alat pertanian, kayu bakar, dan pakan ternak. Pengetahuan tradisional tentang tumbuhan buah-buahan liar secara sangat berhubungan dengan lokasi penelitian, kelompok umur, dan tingkat pendidikan responden.

Kesimpulan: Bengkulu memiliki jenis tumbuhan buah-buahan liar yang beragam, namun hanya sebagian kecil yang telah dimanfaatkan oleh masyarakat setempat, terutama sebagai bahan pangan. Promosi dan domestikasi jenis tumbuhan buah-buahan liar perlu menjadi prioritas utama di Bengkulu sebagai upaya memanfaatkan nilai gizi dan potensi nilai ekonominya. Selain itu, mengintegrasikan pengetahuan terkait jenis tumbuhan buah-buahan liar ke dalam kurikulum pendidikan sangat penting untuk mendidik generasi muda terkait potensi jenis tumbuhan buah-buahan liar dimasa yang akan datang.

Kata kunci: Bengkulu, biodiversitas, pengetahuan lokal, tumbuhan buah-buahan liar, tumbuhan yang kurang dimanfaatkan

Background

Wild edible fruit plants (WEFs) are fruit-producing plants that have not been cultivated and are harvested from their natural habitats (Beluhan & Ranogajec 2011). WEFs represent the majority of wild food plants (Chua-Barcelo 2014), and many wild fruits are widely consumed (FAO 2014). These plants have been recommended as adequate sources of antioxidants, minerals, and vitamins (Kamatou *et al.* 2011; Mahapatra & Panda 2011; Bvenura & Sivakumar 2017; Suwardi *et al.* 2022a). In addition to being an important food source, WEFs are also widely used in medicine (Navia *et al.* 2021a), cosmetics (Gebauer *et al.* 2016), crafts (Hazarika & Singh 2018), fiber (Karun *et al.* 2014), fuel (Debela *et al.* 2012), and material rituals (Sutrisno *et al.* 2020). Each community group has distinct traditional knowledge of the use of WEFs that distinguishes it from other groups. For example, the local communities in the Philippines are used WEFs as food, medicine, forage, offertory, condiment, dye, and decoration (Chua-Barcelo 2014), while in Bhutan and Rwanda used WEFs as food, medicine, firewood, timber, charcoal, shade, and fodder (Bigirimana *et al.* 2016; Yangdon *et al.* 2022). Most WEFs are also known to have economic value and contribute significantly to the generation of income for rural people around the world, e.g. Indonesia (Suwardi *et al.* 2020; Syamsuardi *et al.* 2022), Malaysia (Ong *et al.* 2012), India (Gusain & Khanduri 2016), Cameroon and Nigeria (Leakey *et al.* 2005; Schreckenber *et al.* 2006), and South Africa (Akinifesi *et al.* 2006). This circumstance demonstrates that WEFs play an important role in the life of many indigenous peoples in the world (Hazarika & Singh 2018).

Indonesia is a biodiversity hotspot, home to over 20,000 flowering plant species (Kusmana & Hikmat 2015), and is considered one of the distribution centers of tropical fruits in the world (Uji 2007). However, most of these plants, particularly wild species, are underutilized and threatened by habitat destruction caused by various human activities

such as agricultural development, settlements, and overexploitation. Intensive commercialization and promotion of high-value fruit crops, including introduced species, has reduced consumer awareness of wild species, including WEFs. These activities have also impacted the deterioration of the traditional use of WEFs in Indonesia. The decrease in plant diversity is considered to be contributing to the extinction of indigenous knowledge (Khasbagan 2008). The increasing erosion of indigenous knowledge of WEFs, as well as the disruption of the coexistence of people and forests, will result in the loss of various WEFs' potential in the long term. Indigenous knowledge of wild food plants, including WEFs, is essential for maintaining cultural heritages, as well as for domestication, conservation, and addressing resource governance and policy. This study aimed, therefore, to investigate wild edible fruit species diversity and their potential in the Bengkulu region, Indonesia.

Materials and Methods

Study area

Bengkulu Province is one of Indonesia's provinces located in the western Bukit Barisan mountains. This area is geographically located at 2°16'S to 3°31'S and 101°01'E to 103°41'E, with elevations ranging from 0 to 1,900 m asl. Bengkulu Province has a tropical climate with two seasons: the rainy season, which lasts from December to March, and the dry season, which lasts from June to September. The average annual air temperature is 28.7°C, while the average annual humidity is 76.8%, and the average annual rainfall is 3,658.1 mm with 23.2 rainy days. Bengkulu Province covers an area of approximately 19,919.33 km² and has a population of 2.032 million people, including 1.039 million men and 993 thousand women. Bengkulu province is divided into 10 districts, 129 sub-districts, and 1,514 villages (BPS-Statistics of Bengkulu Province 2022). The ethnobotanical study was carried out in eight villages from four districts of Bengkulu province, Indonesia, i.e. Mukomuko, Lebong, Rejang Lebong, and Bengkulu Selatan (Fig. 1, Table 1).

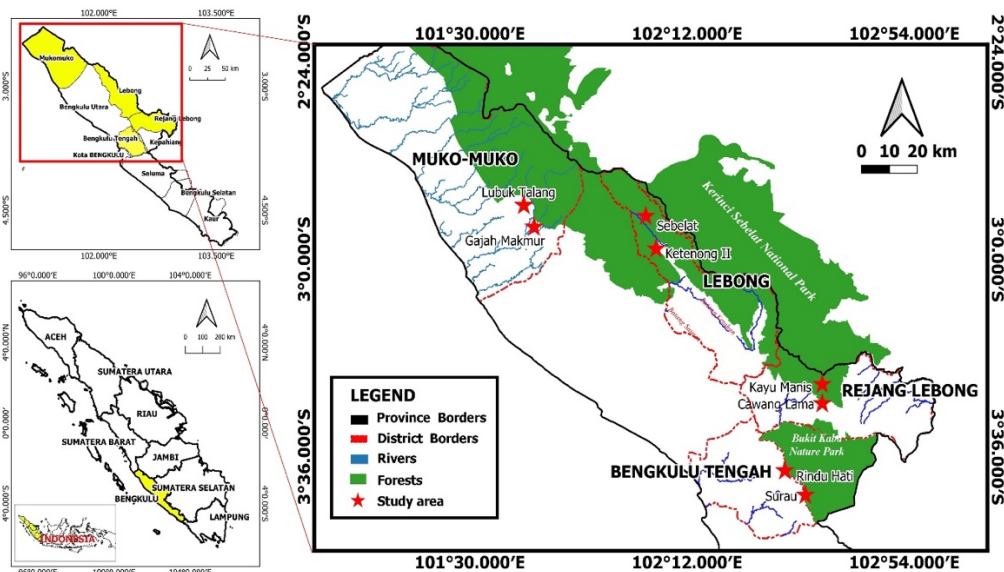


Figure 1. Map of Bengkulu province, Indonesia, showing the study area

Table 1. Description of the selected study villages

District	Sub-district	Name of village	Area (km ²)	No. of population	No. of respondents involved in the study
Mukomuko	Malin Deman	Lubuk Talang	68.75	1,327	56
		Gajah Makmur	19.24	1,143	48
Lebong	Pinang Belapis	Sebelat Ulu	2.00	334	14
		Ketenong Dua	5.00	579	24
Rejang Lebong	Selupu Rejang	Kayu Manis	21.93	1,097	46
		Cawang Lama	9.18	2,863	121
Bengkulu Tengah	Taba	Rindu Hati	12.93	1,142	48
	Penanjung	Surau	12.72	598	25
Total			25.65	9,083	383

Ethnobotanical survey

The ethnobotanical survey was carried out from July to September 2022. The sample size was calculated using the Cochran sample size formula (Bartlett et al., 2001). A total of 383 respondents were chosen at random, with 54.3% of them being women, 27.7% being between the ages of 45 and 55, and the majority (33.2%) having completed Junior High School (Table 2).

Table 2. Socio-demographic characteristics of the respondents

Characteristics	Study area			
	Mukomuko	Lebong	Rejang Lebong	Bengkulu Tengah
Gender				
Men	46	17	76	34
Women	58	22	91	39
Age				
15-25	17	5	23	14
26-35	16	8	41	18
36-45	30	12	53	16
46-55	33	9	43	13
56-65	8	5	7	12
Latest education				
No Education	12	6	18	7
Elementary School	38	8	42	16
Junior High School	37	13	51	26
Senior High School	15	11	37	18
Higher Education	2	1	19	6

The ethnobotanical investigation uses semi-structured questionnaires to gather information on the traditional knowledge of WEFs, such as their local names, utilization, plant parts used, mode of preparation and consumption, and transfer knowledge. The aims of the study were clearly explained to informants prior to conducting interviews, and their consent was obtained. During the survey, plant specimens were collected. The voucher specimens were identified at ANDA herbarium, Universitas Andalas, West Sumatra, Indonesia. Plants of the World Online (<https://powo.science.kew.org/>) was used to update the botanical name.

Data Analysis

The data were analyzed using descriptive statistics, relative frequency citation, and preference ranking. Ethnobotanical data were organized using Microsoft Excel spreadsheets.

The ethnomedicinal data was assessed using a relative frequency citation (RFC) index (Vitalini et al., 2013):

$$RFC = FC/N (0 < RFC < 1)$$

Where, FC is the frequency of citation; N is the total number of respondents participating in the study, without considering use categories into account.

Chi-square tests were used to compare indigenous knowledge and gender groups, and Kruskal-Wallis tests were used to compare indigenous knowledge, age, and education level. IBM-SPSS ver. 21 software was used for the statistical analysis.

Results**Diversity of wild edible fruit species**

A total of 73 wild edible fruit plant species belonging to 37 genera and 26 families were recorded in the study area (Table 3). Most of the plant species were trees (87.7%), followed by shrubs (5.5%), climbers (4.1%), and herbs (2.7%). Forty-eight (79.5%) species were discovered in the forest, 7 (9.6%) in the farmlands, and 8 (11%) in both the forest and the farmlands. In terms of the number of species, Moraceae was the most dominant botanical family with 13 species, followed by Phyllanthaceae and Fagaceae (8 species each), Clusiaceae (4 species), and Anacardiaceae, Malvaceae, Melastomataceae, Meliaceae, and Myrtaceae represented by 3 species each. The remaining 17 families are represented by one to two species.

Table 3. Wild edible fruit plant species reported by the local people in Bengkulu

Family	Scientific name (Vouchers No.)	Local name	Life form	Habitat	Plant part used	Use (s)	District
Anacardiaceae	<i>Mangifera caesia</i> Jack RH-014	Binjai	T	F, Fm	Fr	Eaten raw	LB, BT
					Le	Fodder	
					St	Agricultural tools	
Anacardiaceae	<i>Mangifera foetida</i> Lour. KM-017	Bacang	T	Fm	Fr	Eaten raw	MK, LB, RL, BT
					St	Agricultural tools	
Anacardiaceae	<i>Mangifera odorata</i> Griff. RH-015	Kuini, Lokop, Po'ak	T	F, Fm	Fr	Eaten raw	MK, LB, RL, BT
					St	Agricultural tools	
Araliaceae	<i>Brassaiopsis glomerulata</i> (Blume) Regel KM-003	Randu	T	F	Fr	Snack	RL
					Le	Vegetable	
Clusiaceae	<i>Garcinia atroviridis</i> Griff. ex T. Anderson SU-020	Kandis	T	F, Fm	Fr	Spices, medicine	MK, LB, RL, BT
					St	Fodder	
	<i>Garcinia cowa</i> Roxb. ex Choisy RH-028	Kandis	T	F	Fr	Spices	MK, LB, BT
	<i>Garcinia parvifolia</i> (Miq.) Miq. LT-023	Kandis Burung	T	F	Fr	Spices	MK
Clusiaceae	<i>Garcinia xanthochymus</i> Hook.f. ex T. Anderson SU-009	Gelugur	T	F	Fr	Spices, medicine	MK, LB, BT
Combretaceae	<i>Terminalia catappa</i> L. LT-029	Ketapang	T	F	Fr	Snack	MK, LB, RL, BT
					St	Agricultural tools, fuelwood	
Combretaceae	<i>Terminalia foetidissima</i> Griff. SU-021	Kedaniang	T	F	Fr	Snack	LB
					St	Fuelwood	
Cucurbitaceae	<i>Zehneria repanda</i> (Blume) C.M.Simmons KM-024	Timun Tikus	C	F	Fr	Vegetable	RL
					Le	Medicine	
Elaeocarpaceae	<i>Elaeocarpus floribundus</i> Blume KM-013	Tapang	T	F	Sd	Snack	LB, RL, BT
					St	Construction materials and agricultural tools	
Euphorbiaceae	<i>Mallotus miquelianus</i> (Scheff.) Boerl. SU-027	Siwabuk	T	F	Sd	Snack	LB, RL
	<i>Mallotus peltatus</i> (Geiseler) Müll.Arg.	Balek angin	T	F	Sd	Snack	MK, LB, RL, BT

	LT-036				Le	Medicine	
Fabaceae	<i>Archidendron bubalinum</i> (Jack) I.C.Nielsen	Kabau	T	F, Fm	Fr	Vegetable	MK, LB
	LT-034				Le	Fodder	
	<i>Parkia singularis</i> Miq.	Petai Meranti	T	F	Fr	Vegetable	MK
	LT-022				Le	Fodder	
Fagaceae	<i>Castanopsis argentea</i> (Bl.) A.DC.	Be'ang	T	F	Sd	Snack	MK, LB, RL
	SU-055				St	Construction material, agricultural tools, and fuelwood	
	<i>Castanopsis clemensii</i> Soepadmo	Be'ang	T	F	Sd	Snack	MK, LB
	SU-001				St	Construction materials and agricultural tools	
	<i>Castanopsis malaccensis</i> Gamble	Be'ang	T	F	Sd	Snack	MK, LB
	SU-001				St	Construction materials and agricultural tools	
	<i>Lithocarpus bancanus</i> (Scheff.) Rehder	Buah Pening, Peneng	T	F	Sd	Snack	MK, LB
	LT-028				St	Construction material, agricultural tools, and fuelwood	
	<i>Lithocarpus hystrix</i> (Korth.) Rehder	Be'ang Kecil	T	F	Sd	Snack	LB, RL
	KM-002				St	Construction materials and agricultural tools	
	<i>Lithocarpus lucidus</i> (Roxb.) Rehder	Buah Pening	T	F	Sd	Snack	MK, LB, RL
	SU-039				St	Construction materials and agricultural tools	
	<i>Lithocarpus reinwardtii</i> (Korth.) A.Camus	Buah Pening	T	F	Sd	Snack	LB, BT
	SU-008				St	Construction material,	

						agricultural tools, and fuelwood	
	<i>Lithocarpus sundaicus</i> (Blume) Rehd. LT-031	Buah Pening	T	F	Sd	Snack	MK, LB
					St	Construction materials and agricultural tools	
Hypoxidaceae	<i>Curculigo capitulata</i> (Lour.) Kuntze KM-028	Petari	H	F, Fm	Fr	Eaten raw	MK, LB, RL, BT
Lauraceae	<i>Litsea angulata</i> Blume SU-013	Medang Kecik	T	F	Fr	Eaten raw	LB
					Le	Fodder	
					St	Agricultural tools	
	<i>Litsea elliptica</i> Blume KM-016	Medang Kerawas	T	F	Fr	Eaten raw	LB, RL, BT
					Le	Fodder	
Malvaceae	<i>Durio lowianus</i> Scort. ex King SU-031	Ajun	T	F	Fr	Eaten raw	LB
					St	Construction materials	
	<i>Durio oxleyanus</i> Griff. SU-038	Ajun landok, Durian daun	T	F	Fr	Eaten raw	MK, LB, RL, BT
					St	Construction materials	
	<i>Sterculia rubiginosa</i> Vent. RH-013	Glumpang	T	F	Fr	Snack	LB, BT
					St	Construction material and fuelwood	
Melastomataceae	<i>Bellucia pentamera</i> Naudin SU-044	Jambu hutan	T	F, Fm	Fr	Eaten raw	MK, LB, RL, BT
	<i>Miconia crenata</i> (Vahl) Michelang. SU-045	Sikaduduk bulu	S	F	Fr	Eaten raw	MK, LB, RL, BT
					Le	Medicine	
	<i>Melastoma malabathricum</i> L. LT-035	Sikaduduk	S	Fm	Fr	Eaten raw	MK, LB, RL, BT
					Le	Medicine	
Meliaceae	<i>Aglaiia crassinervia</i> Kurz ex Hiern KM-009	Unknown	T	F	Fr	Eaten raw	LB, RL
	<i>Aglaiia silvestris</i> (M.Roem.) Merr. SU-016	Unknown	T	F	Fr	Eaten raw	LB
					Le	Medicine	
					St	Construction material	
	<i>Epicharis parasitica</i> (Osbeck) Mabb.	Air-air	T	Fm	Fr	Eaten raw	RL

	RH-019						
Moraceae	<i>Artocarpus elasticus</i> Reinw. ex Blume SU-002	Bungkus	T	F	Sd	Snack	MK, LB, RL, BT
	<i>Artocarpus integer</i> (Thunb.) Merr. RH-024	Cempedak Hutan	T	F, Fm	Fr	Eaten raw	MK, LB, RL, BT
					Sd	Snack	
					Le	Fodder	
	<i>Artocarpus lacucha</i> Buch.-Ham. LT-029	Ketapang	T	F	Fr	Eaten raw	MK
					Le	Fodder	
	<i>Artocarpus odoratissimus</i> Blanco RH-026	Terap	T	F	Sd	Snack	MK, LB, RL, BT
	<i>Artocarpus rigidus</i> Blume RH-005	Cempedak Hutan	T	F	Sd	Snack	MK, LB, RL, BT
	<i>Ficus fistulosa</i> Reinw. ex Blume RH-017	Ao	T	F	Fr	Eaten raw	MK, LB, RL, BT
					Ro	Medicine	
	<i>Ficus glandulifera</i> (Wall. ex Miq.) King RH-037	Ao	T	F	Fr	Eaten raw	LB, BT
	<i>Ficus hispida</i> L.f. KM-015	Buah Kodok, Lau	T	F	Fr	Eaten raw	MK, LB, RL, BT
	<i>Ficus racemosa</i> L. KM-018	Buah Plas	T	F	Fr	Eaten raw, medicine	LB, RL, BT
					Le	Medicine	
	<i>Ficus ribes</i> Reinw. ex Blume SU-003	Kodok/Aro Tanah	T	F	Fr	Eaten raw	MK, LB, RL, BT
	<i>Ficus sagittata</i> Vahl RH-039	Ao	C	F	Fr	Eaten raw	LB, RL, BT
	<i>Ficus variegata</i> Blume KM-032	Ao	T	F	Fr	Eaten raw	RL
	<i>Ficus virens</i> Aiton KM-036	Ao	T	F	Fr	Eaten raw, salad	MK, LB, RL
					Le	Vegetable	
Myristicaceae	<i>Horsfieldia polyspherula</i> (Hook.f. ex King) J.Sinclair SU-010	Semalo Abang	T	F	Fr	Spices	LB
	<i>Myristica elliptica</i> Wall. ex Hook.f. & Thomson LT-014	Pala Hutan	T	F	Fr	Spices	MK, LB, BT
					St	Agricultural tools	
Myrtaceae	<i>Syzygium antisepticum</i> (Blume) Merr. & L.M.Perry	Jambu rimba	T	F	Fr	Eaten raw	MK, LB

	LT-037						
	<i>Syzygium polyanthum</i> (Wight) Walp.	Salam	T	Fm	Fr	Eaten raw	MK, LB, RL, BT
	KM-028				Le	Spices, medicine	
	<i>Syzygium pycnanthum</i> Merr. & L.M.Perry	Jambu air	T	F	Fr	Eaten raw	MK, LB, RL, BT
	SU-048				Le	Fodder	
Passifloraceae	<i>Passiflora foetida</i> L.	Rebis	C	Fm	Fr	Eaten raw	MK, LB, RL, BT
	RH-009						
Pentaphylacaceae	<i>Eurya nitida</i> Korth.	Gi'ok	T	F	Fr	Eaten raw	LB
	SU-034						
Phyllanthaceae	<i>Baccaurea deflexa</i> Müll.Arg.	Kisip	T	F	Fr	Eaten raw	RL
	KM-022						
	<i>Baccaurea lanceolata</i> (Miq.) Müll.Arg.	Buah Lepsuak, Lempaung	T	F	Fr	Eaten raw, medicine	MK, LB, RL, BT
	SU-005				Le	Medicine	
	<i>Baccaurea macrocarpa</i> (Miq.) Müll.Arg.	Kayu Abuk, Tapuih	T	F	Fr	Eaten raw	MK, LB, RL, BT
	SU-006						
	<i>Baccaurea parviflora</i> (Müll.Arg.) Müll.Arg.	Tapuih Tuhu	T	F	Fr	Eaten raw	MK, LB
	SU-017						
	<i>Baccaurea polyneura</i> Hook.f.	Jetik	T	F	Fr	Eaten raw	MK, LB, RL, BT
	RH-012						
	<i>Baccaurea racemosa</i> (Reinw. ex Blume) Müll.Arg.	Tupak	T	F	Fr	Eaten raw	MK, LB, RL, BT
	RH-020						
	<i>Baccaurea ramiflora</i> Lour.	Tapoi	T	F	Fr	Eaten raw	MK, LB
	SU-040						
	<i>Baccaurea sumatrana</i> (Miq.) Müll.Arg.	Seripis, pasak	T	F	Fr	Eaten raw	MK, LB, RL, BT
	SU-015				Le	Medicine	
Rosaceae	<i>Nauclea orientalis</i> (L.) L.	Monteng/Stewel	T	F	Fr	Eaten raw	LB, RL
	KM-019				Le	Vegetable, medicine	
	<i>Rubus moluccanus</i> L.	Spinget blando	S	Fm	Fr	Eaten raw	MK, LB, RL, BT
	SU-032						
Salicaceae	<i>Flacourtia rukam</i> Zoll. & Moritzi	Rukam manis	T	F, Fm	Fr	Eaten raw	MK, LB, RL, BT
	KM-006				Le	Medicine	
	<i>Flacourtia inermis</i> Roxb.	Rukam masam	T	F, Fm	Fr	Eaten raw	RL

	KM. 020						
Sapindaceae	<i>Mischocarpus pentapetalus</i> (Roxb.) Radlk.	Unknown	T	F	Fr	Eaten raw	LB
	SU-023						
	<i>Nephelium uncinatum</i> Radlk. ex Leenh.	Rambutan hutan	T	F	Fr	Eaten raw	MK, LB
	LT-027						
	<i>Pometia pinnata</i> J.R.Forst. & G.Forst.	Kasai, Kasai Hutan, Ungkilanang	T	F	Fr	Eaten raw	MK, LB, RL, BT
	LT-001						
Sapotaceae	<i>Madhuca utilis</i> (Ridl.) H.J.Lam	Balem gunung	T	F	Fr	Eaten raw	LB
	SU-033				Sd	Vegetable oil	
					St	Construction materials	
Solanaceae	<i>Physalis angulata</i> L.	Ciplukan	H	Fm	Fr	Eaten raw	MK, LB, RL, BT
	RH-024				Le	Medicine	
Vitaceae	<i>Leea indica</i> (Burm. f.) Merr.	Malai	S	F	Fr	Eaten raw	LB
	SU-035				Le	Vegetable, medicine	

Legend:

Life form: T = Tree, S = Shrub, H = Herb, C = Climber; **Habitat:** F = Forest, Fm = Farmland;

Plant part used: Ro = Root, St = Stem, Le = Leaf, Fr = Fruit, Sd = Seed; **District:** MK = Mukomuko; LB = Lebong; RL = Rejang Lebong; BT = Bengkulu Tengah

Wild edible fruit for food purposes

Local people in the study area live near the forest and have long relied on various wild species for their livelihoods. Our findings show that 73 WEFs have been discovered in the Bengkulu region, with eleven (15%) species being the most frequently cited by local people in the study area (RFC > 0.08). The top five most cited WEFs are *Artocarpus integer*, *Mangifera odorata*, *Bellucia pentamera*, *Garcinia atroviridis*, and *Mangifera foetida* (Figure 2).

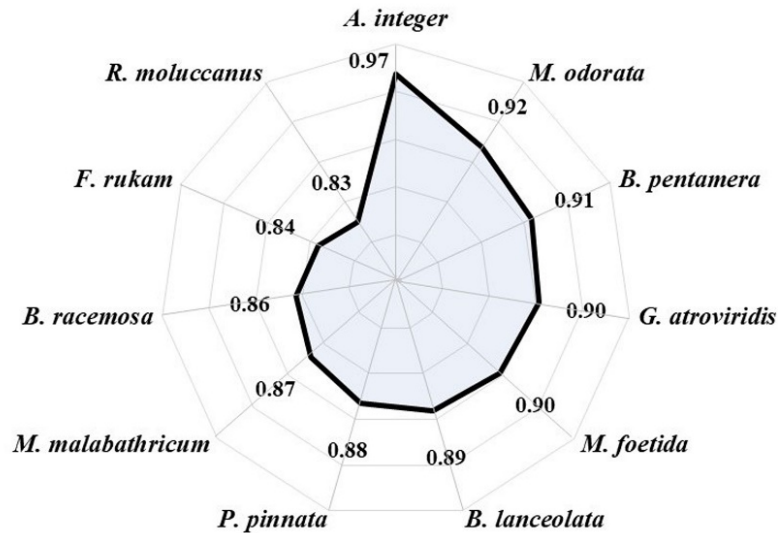


Figure 2. Relative frequency citation (RFC) of wild edible fruits in the study area

The local people in the study area primarily use WEFs for food. The most consumed plant parts were fruit (74.3%), followed by seeds (20.3%), and leaves (5.4%). Plants were consumed in two methods: raw and cooked. Fruits are eaten raw, seeds are usually roasted and eaten as snacks, and young leaves are usually cooked as vegetables. During the discussion, all respondents state that they harvested WEFs for self-consumption.

The top 10 most preferred WEFs by their taste quality were *Artocarpus integer*, *Mangifera odorata*, *Pometia pinnata*, *Flacourtia rukam*, *Durio oxleyanus*, *Baccaurea racemosa*, *Bellucia pentamera*, *Baccaurea macrocarpa*, *Baccaurea polyneura*, and *Mangifera foetida*. *Artocarpus integer* is the most popular WEFs, preferred by the majority of respondents across all studied villages (preference ranking; Table 4).

Table 4. Results of preference ranking of top ten wild edible fruit species by their taste quality (1 = least, 2 = less, 3 = good, 4 = very good, and 5 = excellent)

Species	Respondents (N=383)								Total Score	Rank
	LT	GM	SU	KD	KM	CL	RH	SR		
<i>Artocarpus integer</i>	4.9	4.7	4.8	4.8	4.8	4.7	4.8	4.7	4.78	1 st
<i>Mangifera odorata</i>	4.6	4.7	4.8	4.7	4.7	4.8	4.7	4.8	4.73	2 nd
<i>Pometia pinnata</i>	4.8	4.6	4.7	4.7	4.8	4.6	4.6	4.7	4.69	3 rd
<i>Flacourtia rukam</i>	4.7	4.2	4.7	4.6	4.6	4.5	4.6	4.6	4.56	4 th
<i>Durio oxleyanus</i>	4.9	4.5	4.8	4.7	4.4	4.2	4.5	4.4	4.55	5 th
<i>Baccaurea racemosa</i>	4.4	4.6	4.7	4.7	4.6	4.3	4.4	4.6	4.54	6 th
<i>Bellucia pentamera</i>	4.2	4.8	4.3	4.7	4.5	4.6	4.8	4.3	4.53	7 th
<i>Baccaurea macrocarpa</i>	4.6	4.4	4.6	4.4	4.4	4.7	4.4	4.6	4.51	8 th
<i>Baccaurea polyneura</i>	4.8	4.2	4.7	4.6	4.4	4.1	4.6	4.5	4.48	9 th
<i>Mangifera foetida</i>	4.4	4.5	4.4	4.4	4.6	4.7	4.3	4.3	4.45	10 th

Legend: LT = Lubuk Talang; GM = Gajah Makmur; SU = Sebelat Ulu; KD = Ketenong Dua; KM = Kayu Manis; CL = Cawang Lama; RH = Rindu Hati; SR = Surau

Wild edible fruit plants used for medicinal purposes

A total of 15 (20.5%) WEFs were used by the local people in the Bengkulu region as traditional medicines. These species were used against 18 human ailments (Table 5).

Table 5. List of wild edible fruits as traditional medicine

Scientific name	Plant part used	Mode of preparation	Route of administration	Disease treated
<i>Aglaia silvestris</i>	Le	Squeezing	External application	Wounds, tonic
<i>Baccaurea lanceolata</i>	Le	Squeezing	External application	Headache
	Fr	Decoction	Oral	Tonsils, obesity
<i>Baccaurea sumatrana</i>	Le	Squeezing	External application	Headache
<i>Ficus fistulosa</i>	Ro	Decoction	Oral	Postpartum infection
<i>Ficus racemosa</i>	Le	Boiling	Oral	Diarrhea, dysentery
		Crushing	External application	Wound
	Fr	Decoction	Oral	Cough
<i>Flacourtia rukam</i>	Le	Decoction	Oral	Diarrhea, dysentery
		Chewing	Oral	Bleeding gums, toothache
<i>Garcinia atroviridis</i>	Fr	Eaten raw	Oral	Obesity
<i>Garcinia xanthochymus</i>	Fr	Eaten raw	Oral	Diarrhea, stomachache, obesity
<i>Leea indica</i>	Le	Crushing	External application	Wound
		Decoction	Oral	Diarrhea, dysentery
<i>Mallotus peltatus</i>	Le	Boiling	Oral	Stomachache
		Squeezing	External application	Skin diseases
<i>Melastoma malabathricum</i>	Le	Squeezing	External application	Wound
<i>Miconia crenata</i>	Le	Squeezing	External application	Wound
<i>Nauclea orientalis</i>	Le	Crushing	External application	Boils
<i>Physalis angulata</i>	Le	Decoction	Oral	Fever, malaria, postpartum infection
		Squeezing	External application	Rheumatism, skin diseases
<i>Syzygium polyanthum</i>	Le	Decoction	Oral	Diarrhea, stomachache

Plant parts used among local people to treat various illnesses were primarily leaves (70.6%), followed by fruits (23.5%) and roots (5.9%). The most commonly used ethnomedicine plant remedies were diarrhea (5 species), followed by wound (4 species each), obesity and stomachache (3 species each), headache, postpartum infection, dysentery, and skin diseases (2 species each), and tonic, tonsils, bleeding gums, toothache, boils, fever, malaria, rheumatism, and cough (1 plant species each).

Wild edible fruit plants used for other purposes

The finding revealed that the people of Bengkulu used WEFs for a variety of purposes. They use these plants for construction, agricultural tools, fuelwood, and fodder, in addition to wild food and medicinal plant uses. A multiple-use analysis revealed that agricultural tools were the most frequently reported (15), while fuelwood was the least reported (6) (Figure 3).

Indigenous knowledge transfer

Local people in the study area have long interacted with nature by relying on a diverse range of wild plant species, including WEFs, for livelihoods. Our findings revealed that people in the Lebong district identified more WEFs than people in other districts. The average number of WEFs identified by each age group of the respondents ranged from 32.48 ± 6.21 (15-25 years) to 45.03 ± 11.32 (56-65 years). Moreover, the average number of species identified by each educational level of the respondent ranged from 33.68 ± 8.49 (Senior High School) to 45.16 ± 10.98 (No education) (Table 6).

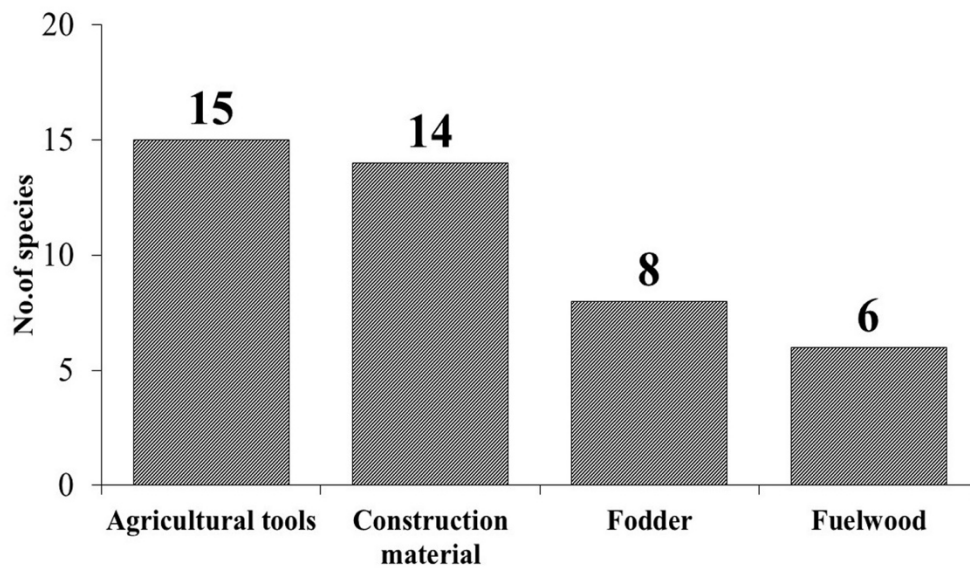


Figure 3. The other uses of the wild edible plant species

Table 6. Comparison of subgroups of respondents on their indigenous knowledge of WEFs

Variable	Total respondents	The average number of WEFs identified	Statistical test	<i>p</i> -value
District			<i>W</i> = 121.234	0.0001
Mukomuko	104	35.23 ± 6.43		
Lebong	39	53.69 ± 6.49		
Rejang Lebong	167	33.03 ± 5.06		
Bengkulu Tengah	73	31.11 ± 5.17		
Gender			$\chi^2 = 51.412$	0.072
Male	175	36.71 ± 9.73		
Female	208	34.63 ± 7.56		
Age			<i>W</i> = 52.247	0.0001
15-25	60	32.48 ± 6.21		
26-35	83	32.57 ± 7.32		
36-45	102	34.88 ± 8.07		
46-55	106	37.48 ± 7.93		
56-65	32	45.03 ± 11.32		
Level Education			<i>W</i> = 39.618	0.0001
No Education	43	45.16 ± 10.98		
Elementary School	104	35.19 ± 6.92		
Junior High School	127	34.20 ± 7.33		
Senior High School	81	33.68 ± 8.49		
Higher Education	28	33.93 ± 6.97		

Traditional knowledge of WEFs varied significantly across the four districts ($p < 0.05$). Local people in the Lebong district possessed significantly more indigenous knowledge than those in other districts. There was no statistically significant difference between men and women in indigenous knowledge ($p > 0.05$). However, there was a significant relationship between age and indigenous knowledge ($p > 0.05$), as well as education level and indigenous knowledge ($p > 0.05$). The findings of the study revealed a decrease in traditional knowledge across age groups, with older people having more knowledge about WEFs than younger people. During the discussion, 58.3% of respondents aged 15-25 claimed that they spent more time at school and, as a result, were rarely involved in WEFs harvesting. In contrast, our findings show that more than 40% of respondents aged 15-25 spend their weekends playing online games.

During the discussion, approximately 68% of respondents stated that they obtain traditional knowledge of the use of WEFs from relatives, 17.8% from friends/neighbors, 8.4% from self-learning by experience, and 5.7% from formal education. This demonstrates that relatives play a significant role in the transmission of traditional knowledge concerning wild plants.

Discussion

A total of 73 WEFs from 26 botanical families were recorded in Bengkulu province, which is comparable to the 67 WEFs reported from Riau, Indonesia (Syamsuardi *et al.* 2022) and 54 wild edible fruit species (27 families) reported from Central Aceh, Indonesia (Navia *et al.* 2020a). However, this is less when compared to 520 WEFs reported in Malaysia (Milow *et al.* 2014) and 129 species in Aceh, Indonesia (Suwardi *et al.* 2022b). WEFs were discovered in the study area primarily as foods. This is in line with previous studies from Riau, Indonesia (Syamsuardi *et al.* 2022), Aceh, Indonesia (Suwardi & Navia 2022), and the Philippines (Chua-Barcelo 2014). WEFs were mostly consumed both raw and cooked or further processed. For example, *Garcinia xanthocymus* and *Garcinia atroviridis* fruits were consumed raw as well as dried as spices. WEFs such as *Artocarpus integer*, *Mangifera odorata*, *Pometia pinnata*, *Flacourtia rukam*, *Durio oxleyanus*, *Baccaurea racemosa*, *Bellucia pentamera*, *Baccaurea macrocarpa*, *Baccaurea polyneura*, and *Mangifera foetida* were relatively common and familiar to the respondents and were extensively listed in all study villages.

The ethnobotanical study reveals that WEFs have multiple uses aside from food, with more citations for their use as a raw material for construction, which is comparable to the reported in other areas of Indonesia, such as in West Aceh, Indonesia (Suwardi & Navia 2022) and East Aceh (Navia *et al.* 2021b). Several species such as *Artocarpus integer* and *Parkia singularis* were reported for fodder purposes. The medicinal use of WEFs generally included traditional remedies to treat common illnesses such as diarrhea, wound, obesity, headache, postpartum infection, dysentery, skin diseases, stomachache, tonic, tonsils, bleeding gums, toothache, boils, fever, malaria, rheumatism, and cough. *Baccaurea lanceolata* and *Garcinia xanthochymus* were the most commonly used WEFs in traditional medicine, particularly for the treatment of metabolic disorders such as obesity.

This study showed that indigenous knowledge of WEFs differed significantly between the districts, with the respondents from Lebong having more knowledge compared to other districts. This demonstrates that their reliance on forest resources is very high, given that the area is located in the forest, and traditional knowledge on the use of forest resources has proven to be able to be transferred very well between generations. In line with several other studies (Chua-Barcelo 2014; Geng *et al.* 2016; Yangdon *et al.* 2022), the association between gender and indigenous knowledge was not statistically significant. Moreover, this finding contrasts with previous studies in another area (Navia *et al.* 2020a; Suwardi *et al.* 2020), in which women reported greater knowledge of wild edibles than men. Our findings, on the other hand, suggest that respondents' age and education level influence their traditional knowledge of WEFs. Respondents aged 15 to 25, the majority of whom are in Senior High School, have less traditional knowledge of WEFs usage. According to the observations and discussions, this decline in knowledge, particularly among respondents who are currently enrolled in school, is caused by the fact that they spend more time at school or in town nowadays. Moreover, we see that the majority of the younger generation (15-25 years) in the study area spends a lot of time on weekends accessing online games via the internet, therefore they are less involved in forest product harvesting. The findings confirm the reports of Navia *et al.* (2020b) and Sujarwo *et al.* (2014), who found that the use of information technology, particularly the internet, has a significant impact on knowledge of the use of wild plants. Furthermore, the declining knowledge of more senior respondents may be due to them having other jobs far outside of the study area, such as in town, and being less involved in natural forest harvesting. The small proportion of elders who used to pass on their traditional knowledge to the younger generation contributes to traditional knowledge loss (Okui *et al.* 2021).

The decreasing use of WEFs by local people has resulted in the extinction of wild food culture and is associated with the eroding of indigenous knowledge. It is critical, therefore, to prioritize the promotion of these underutilized species before wild food culture consumption becomes redundant. Efforts to domesticate various useful wild species, including WEFs, must, on the other hand, be initiated by growing these species mixed with crops in their farmland, home garden, or orchard through the implementation of agroforestry practices. Agroforestry practices have been proven to promote biodiversity conservation (Sistla *et al.* 2016), as well as boost the economic growth of communities surrounding forests, and provide sufficient opportunities for the younger generation to learn more about wild species, including WEFs. WEFs may also be promoted by incorporating WEF knowledge into local subjects in schools.

Conclusions and Recommendations

A total of 73 WEFs representing 26 botanical families were discovered in Bengkulu. These plants have been used by the local people for a variety of purposes, including food, medicine, construction materials, agricultural tools, fuelwood, and fodder. Despite the fact that the study discovered a high diversity of WEFs, local people in Bengkulu only used an average of 47 (64%) species. As a result, future research on potential WEFs, including nutritional value, is critical to promoting and conserving WEFs. The study also discovered that younger generations have less indigenous knowledge than older generations, recommending that WEFs knowledge be incorporated into educational curricula.

Declarations

Ethical approval and consent to participate: Permission was taken from the head of the district of Mukomuko, Lebong, Rejang Lebong, and Bengkulu Tengah before data collection. Oral agreements were obtained from local respondents and all field data were collected through their oral approval.

Consent for publication: Not applicable.

Availability of data and materials: Data will be available from the corresponding author in a special request.

Conflict of interests: The authors declare no competing interests.

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Authors' contributions: ABS, S, EM, and N carried out fieldwork and data analysis. ABS and S configured the research project. ABS drafted the manuscript. All authors read, reviewed, and approved the final version of the manuscript.

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