The diversity and traditional knowledge of wild edible vegetables in Aceh, Indonesia

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Research

Abstract

Background: Wild edible vegetables 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 wild edible vegetables are less well-known and underutilized. This study aimed to investigate wild edible vegetable species diversity and their potential in the Aceh region, Indonesi

Methods: The ethnobotanical study was carried out in two districs, i.e. Aceh Selatan and Aceh barat Daya. The ethnobotanical survey was carried out from May to June 2023 and included 383 randomly selected respondents. The ethnobotanical investigation uses semi-structured questionnaires to gather information on the traditional knowledge of wild edible vegetables. Plant specimens were collected and identified in Universitas Samudra.

Results: A total of 86 wild species belonging to 35 families and 67 genera were documented as being consumed as vegetables by local people in the study area. In terms of frequency of citation, only 28 taxa were cited by 75% or more of the interviewed people, 17 (20%) vegetable taxa were commonly gathered and consumed, 35 (41.2%) were rarely cited - ranging from 5 to 20% of informants, and 5 were very rarely cited. *Artocarpus integer, Archidendron bubalinum, Etlingera elatior, Macrothelypteris torresiana, Stenochlaena palustris, Bambusa vulgaris, Colocasia esculenta, Pseudosasa japonica, Diplazium esculentum*, and *Ipomoea aquatica* are the ten most cited vegetables in the study area. Despite the fact that the study discovered a high diversity of wild edible vegetables, local people in Kluet Tengah only used an average of 31.11 ± 9.21 species out of 57 species recorded. Most of the reported vegetables were consumed cooked (74 species), eaten raw (2), both cooked and raw (3), and 5 species were added as a spice to the dish. Indigenous knowledge of wild edible vegetables was significantly associated with districts, age groups, and educational levels.

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

Keywords: Aceh, biodiversity, local knowledge, wild vegetable, underutilized plants

Abstrak

Latar Belakang: Sayuran liar memberikan kontribusi signifikan terhadap kesejahteraan manusia. Tumbuhan ini memiliki nilai gizi yang tinggi dan merupakan sumber alel/gen baru yang penting dalam pengembangan kultivar tanaman baru dan lebih baik untuk meningkatkan ketahanan pangan berkelanjutan. Meskipun demikian, sebagian besar sayuran liar kurang dikenal dan kurang dimanfaatkan. Penelitian ini bertujuan untuk mengetahui keanekaragaman sayuran liar dan potensinya di wilayah Aceh, Indonesia.

Metode: Penelitian dilakukan di dua kabupaten, yaitu Aceh Selatan dan Aceh Barat Daya. Survei etnobotani dilakukan pada bulan Mei hingga Juni 2023 dan melibatkan 383 responden yang dipilih secara acak. Koleksi data etnobotani menggunakan kuesioner semi-terstruktur untuk mengumpulkan informasi tentang pengetahuan tradisional tentang sayuran liar. Spesimen tumbuhan dikumpulkan dan diidentifikasi di Universitas Samudra.

Hasil: Sebanyak 86 spesies sayuran liar yang termasuk dalam 35 suku dan 67 marga ditemukan dikonsumsi sebagai sayuran oleh masyarakat lokal di lokasi penelitian. Meskipun demikian, hanya 28 taksa yang dikonsumsi oleh 75% orang atau lebih yang diwawancarai, 17 (20%) taksa sayuran yang umum dikonsumsi, 35 (41,2%) jarang dikonsumsi, dan 5 jenis sangat jarang dikonsumsi. *Artocarpus integer, Archidendron bubalinum, Etlingera elatior, Macrothelypteris torresiana, Stenochlaena palustris, Bambusa vulgaris, Colocasia esculenta, Pseudosasa japonica, Diplazium esculentum*, dan *Ipomoea aquatica* adalah sepuluh jenis sayuran yang paling banyak dimanfaatkan oleh masyarakat di lokasi penelitian. Meskipun penelitian ini menemukan keanekaragaman jenis sayuran liar yang tinggi, masyarakat lokal di Kluet Tengah hanya memanfaatkan rata-rata 31.11 ± 9.21 jenis dari 57 jenis yang ditemukan. Sebagian besar sayuran dikonsumsi dalam bentuk dimasak (74 jenis), dimakan mentah (2 jenis), dimasak dan mentah (3 jenis), dan 5 jenis ditambahkan sebagai bumbu masakan. Pengetahuan masyarakat lokal mengenai sayuran liar yang dapat dimakan berhubungan secara signifikan dengan kabupaten, kelompok umur, dan tingkat pendidikan.

Kesimpulan: Aceh memiliki beragam jenis sayuran liar yang dapat dimakan, namun hanya sebagian kecil yang dimanfaatkan oleh masyarakat setempat, khususnya sebagai makanan. Promosi dan budidaya sayuran liar harus menjadi perhatian utama di Aceh untuk memanfaatkan nilai gizi dan potensi nilai ekonominya. Selain itu, mengintegrasikan pengetahuan terkait sayuran liar ke dalam kurikulum pendidikan sangat penting untuk mendidik generasi berikutnya mengenai potensi sayuran liar di masa depan.

Kata kunci: Aceh, biodiversitas, pengetahuan lokal, sayuran liar, tumbuhan kurang termanfaatkan

Background

Today, less than 30 species account for over 90% of world food production, while 12 domesticated species account for more than 85% of total caloric consumption (Misra et al. 2008). In the future, this circumstance could place tremendous biotic and abiotic pressure on modern agriculture. Wild edible plants may contribute to promoting sustainability by minimizing the risk of over-dependence on particular crops. Approximately 7,000 plant species are cultivated or harvested for food or medical uses from natural vegetation around the world (Ghane et al. 2010). Wild plants supply important nutrients as alternative food sources that can be consumed raw or processed into food ingredients (Navia et al. 2020; Suwardi et al. 2022), and they are critical for ensuring global food security (Akbulut 2022; Navia et al. 2022). Wild plants provide a diverse set of genetic resources for crop production. Many wild plants have useful characteristics, such as resistance to diseases, pests, and severe environmental circumstances, which can be transferred into more productive and robust crop varieties through breeding (Swarup et al. 2021). Maintaining diversity in Plant Genetic Resources (PGRs) is critical for crop development and genetic improvement (Salgotra and Chauhan 2023). Moreover, sustainable use of wild plants not only increases food security but also relieves the load on key food crops and minimizes vulnerability to climate change, which can disrupt food supply.

Wild edible vegetable species (WEVs) refer to plants that grow naturally in the wild environment and can be consumed as food. They are not commercially cultivated and are often found in forests and other open areas. Although they may be less familiar in mainstream society, WEVs provide a nutritious alternative for those interested in natural food sources. WEVs are very important for the intake of dietary fiber, which improves intestinal peristalsis and reduces the glycaemic index of a meal (Nomikos et al. 2007). A high level of vegetable consumption produces an overall positive effect on human health. In Indonesia, the use of wild vegetables, including WEVs, is strictly linked to the traditional cuisine of each province (Sutrisno et al. 2021; Syamsuardi et al. 2022; Nurainas et al. 2021; Adnan et al. 2022), and it includes the traditional knowledge about cooking methods and the particular events at which they are consumed

WEVs play an essential role, particularly in rural areas, as a source of nourishment. However, existence in nature is jeopardized by a variety of factors. One of the most serious threats is the destruction of habitat caused by urbanization, deforestation, and agricultural expansion, which reduces the natural areas in which these plants live. Overharvesting of wild vegetable plants for commercial purposes can also reduce populations and upset natural balance. The decline or extinction of one wild population or species in a specific area can have an impact on other species, in particular those used for economic and cultural purposes (Shackleton et al. 2018), and may harm the livelihoods and economies of NTFP-based communities (Pandey et al. 2016). Several studies indicate an intergenerational loss in traditional knowledge of wild plants (Sujarwo et al. 2014; Navia et al. 2020). Traditional knowledge passed down through generations frequently includes information on the collection, cultivation, and usage of wild plants in communities. The loss of traditional knowledge increases the risk that the ecologically and culturally valuable WEVs will be neglected or eventually extinct. As a result, efforts to preserve and promote traditional knowledge are crucial for maintaining the diversity of WEVs and the associated ecosystems. This study aimed to investigate wild edible vegetable species diversity and their potential for food in the Aceh region, Indonesia.

Materials and Methods

Study area

Aceh province is located between 01°58'37.2" - 06°04'33.6"N and 94°57'57.6" - 98°17'13.2"E with an average altitude of 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. The present study was conducted in two districts (Table 1), namely Aceh Selatan and Aceh Barat Daya (Figure 1).

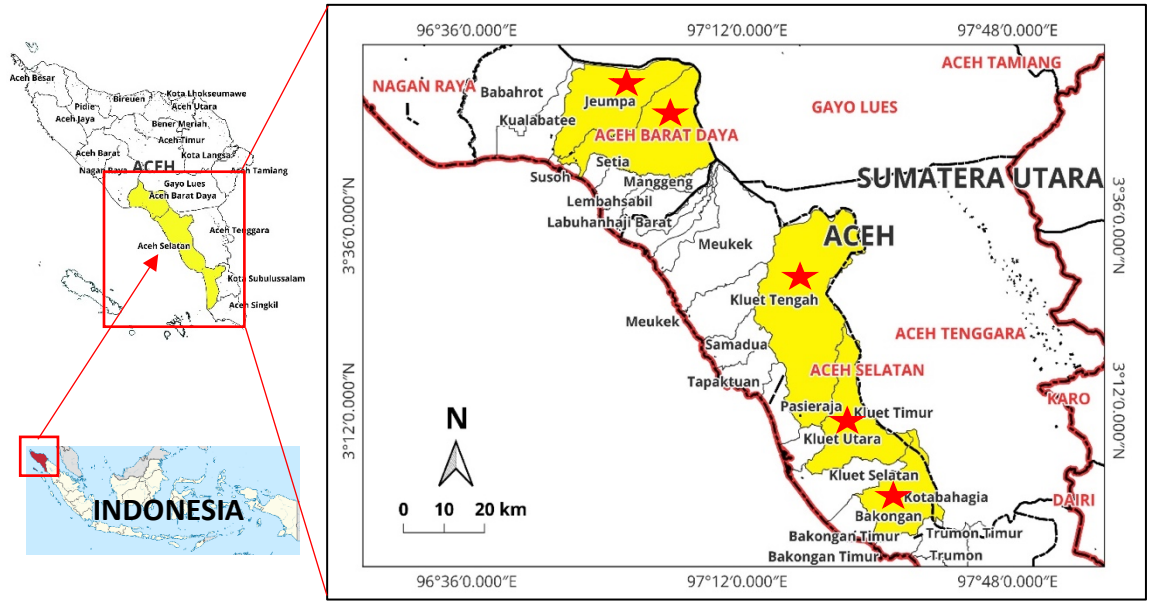

Figure 1. Map of Aceh province, Indonesia, showing the study area

Table 1. Description of the selected study villages

District	Sub-district	Village	Area (km^2)	No. of population	No. of respondents involved in the study
Aceh Selatan	Kota Bahagia	Jambo Keupok	51.85	1,114	48
		Sineubok Kuranji	45.41	484	21
	Kluet Tengah	Malaka	3.44	790	34
		Koto	1.94	1,354	59
	Kluet Timur	Lawe Sawah	7.17	1,038	45
		Lawe Buluh Didi	1.85	298	13
Aceh Barat Daya	Blang Pidie	Panton Raya	16.18	292	13
		Seunaloh	3.01	902	39
	Jeumpa	Alue Sungai Pinang	0.91	1,861	81
		Alue Rambot	54.36	677	29
Total			**195.12**	**8810**	**383**

Ethnobotanical survey

The ethnobotanical investigation was conducted from May to June 2023 and included 383 randomly selected respondents from 10 villages. All respondents are from indigenous communities. The sample size was calculated using the Cochran sample size formula (Bartlett et al. 2001). Two hundred and twenty-two (57.9%) of those respondents were women, most of respondents between the ages of 46 and 55, and the majority having completed Junior High School (Table 2).

Table 2. Socio-demographic characteristics of the respondents

Characteristics	Study area		Total	Percentage (%)
	Aceh Selatan	Aceh Barat Daya		
Gender				
Men	88	73	161	42.04
Women	133	89	222	57.96
Age				
15-25	31	24	55	14.36
26-35	46	42	88	22.98
36-45	64	31	95	24.80
46-55	59	53	112	29.24
56-65	21	12	33	8.62
Latest education				
None Education	29	16	45	11.75
Elementary School	48	42	90	23.50
Junior High School	56	59	115	30.03
Senior High School	64	33	97	25.33
Higher Education	24	12	36	9.40

The ethnobotanical investigation uses semi-structured questionnaires to gather information on the traditional knowledge of wild edible vegetables, such as their local names, utilization, plant parts used, mode of preparation and consumption, and transfer knowledge. The respondents were invited to compare the usage of wild edible vegetables depending on their preference and importance. Each respondent arranged the uses based on personal preference and perceived importance to the community on a 0 to 5 scale, with 0 representing no value and 5 representing the highest value.

During the survey, all the plant species mentioned by the respondents were collected. The voucher specimens were identified at Universitas Samudra, Aceh, 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 the use categories 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. 22 software was used for the statistical analysis.

Results

Diversity of wild edible vegetable

The data was gathered after interviewing 383 individuals, and a total of 86 wild species belonging to 35 families and 67 genera were documented as being consumed as vegetables by local people in the study area. The most represented were Poaceae, with 9 genera and 18 taxa (21.18%); Moraceae, with 2 genera and 7 taxa (8.24%); Araceae, Aspleniaceae, and Asteraceae, with 5 taxa (5.88%); Fabaceae, with 4 genera and 4 taxa (4.71%); Amaranthaceae, Arecaceae, and Musaceae, with 3 taxa (3.53%); Convolvulaceae, Cucurbitaceae, Lamiaceae, Passifloraceae, Phyllanthaceae, Rutaceae, and Zingiberaceae, with 2 taxa (2.35%); and 18 remaining botanical families (1.18%) represented by 1 taxon (Table 3). Considering growth habit, there were mainly herbs (35.3%), followed by shrubs (29.4%), trees (18.8%), climbers (11.8%), creeper (3.5%), and roots hydrophyte (1.2%) (Figure 2).

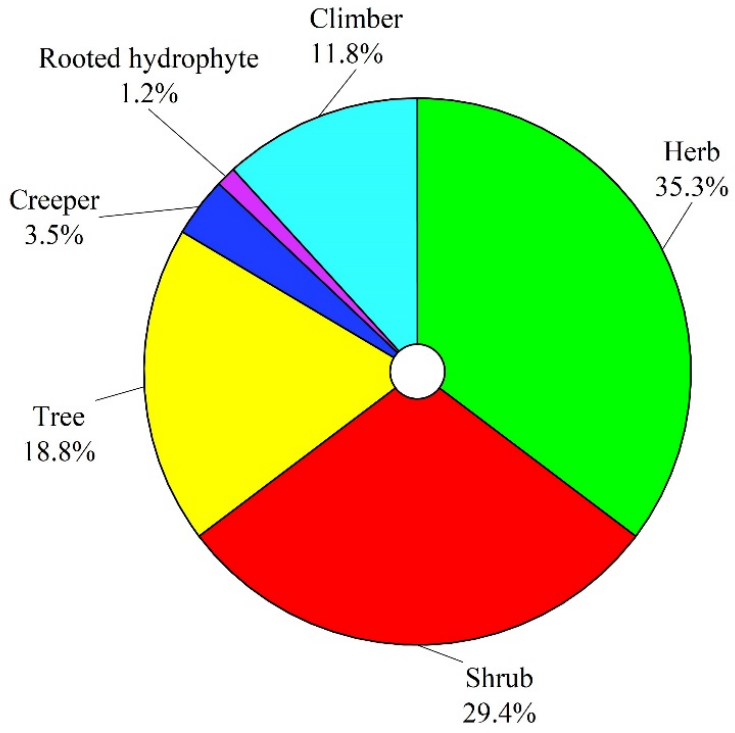

Figure 2. Relative frequency citation (RFC) of wild edible fruits in the study area

In terms of frequency of citation, only 28 taxa were cited by 75% or more of the interviewed people, 17 (20%) vegetable taxa were commonly gathered and consumed, 35 (41.2%) were rarely cited - ranging from 5 to 20% of informants, and 5 were very rarely cited (Tables 1). *Artocarpus integer, Archidendron bubalinum, Etlingera elatior, Macrothelypteris torresiana, Stenochlaena palustris, Bambusa vulgaris, Colocasia esculenta, Pseudosasa japonica, Diplazium esculentum*, and *Ipomoea aquatica* are the ten most cited vegetables in the study area (Figure 3). Several species, including *Artocarpus integer*, *Archidendron bubalinum, Diplazium esculentum*, and *Ipomoea aquatica*, are additionally being sold in market villages.

Table 3. List of wild edible vegetables in the study area

Family	Scientific name	Local name	Growth Habit	Edible part(s)	Mode of consumption
Amaranthaceae	*Amaranthus spinosus* L.	Bayam duri	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Amaranthus tricolor L.	Bayam mirah	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Amaranthus viridis L.	Bayam liar	Herb	Leaf, inflorescence	Young leaves and inflorescence are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Anacardiaceae	*Mangifera foetida* Lour	Mancang	Tree	Fruit	The fruit is used in the preparation of mango sauce. The ripe fruit is chopped, mixed with chile, salt, and brown sugar, and then mashed.
Apiaceae	*Centella asiatica* (L.) Urb.	Pegagan	Creeper	Whole plant	Whole plants are chopped into small pieces and boiled or mixed with potato and chili mashed.
Araceae	*Alocasia macrorrhizos* (L.) G.Don	Empeuk bawang	Shrub	Whole plant	The leaves and stems are chopped into small pieces, cooked, and eaten as a vegetable. The tubers are sliced into small pieces and served as vegetables or steamed for snacks.
	Colocasia esculenta (L.) Schott	Taleh siah, Taleh kemahang	Herb	Whole plant	The leaves and stems are chopped into small pieces, cooked, and eaten as a vegetable. The tubers are sliced into small pieces and served as vegetables or steamed for snacks.
	Peltandra virginica (L.) Schott	Bak deng	Herb	Whole plant	The leaves and stems are chopped into small pieces, cooked, and eaten as a vegetable. The tubers are sliced into small pieces, soaked in sugar solution, and boiled to remove the calcium oxalate crystals. The tubers are served as vegetables or fried for snacks.
	Typhonium flagelliforme (G.Lodd.) Blume	Keladi tikoh	Herb	Tuber	The tubers are sliced into small pieces and served as vegetables or steamed for snacks.
	Xanthosoma sagittifolium (L.) Schott	Empeuk ijo	Herb	Stem, fruit	Stem and young fruits are cooked and eaten as a vegetable.
Araliaceae	*Hydrocotyle moschata* G.Forst	Semangi gunung	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Arecaceae	*Calamus draco* Willd	Rotan	Climber	Stem	Young stems are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Eleiodoxa conferta (Griff.) Burret	Asam kelube	Shrub	Fruit	Fruits are added as a spice to a dish
	Metroxylon sagu Rottb.	Buah mio	Tree	Stem	Young stems are chopped into small pieces, boiled, and mixed with other vegetables. Salt and spices are added to taste.

Aspleniaceae	*Thelypteris parasitica* (L.) Tardieu	Paku kayu	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Thelypteris interrupta (Willd.) K.Iwats.	paku beras	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Diplazium esculentum (Retz.) Sw.	Paku, pakis, oun paku, Pakoe gampong	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Macrothelypteris torresiana (Gaudich.) Ching	Paku breuh	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Stenochlaena palustris (Burm.f.) Bedd	Paku Mirah	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Asteraceae	*Ageratum conyzoides* L.	Kambing landok	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Blumea balsamifera (L.) DC.	Daun safa	Shrub	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Elephantopus scaber L	Sawi hutan	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Pluchea indica (L.) Less.	Baluntas	Shrub	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Elephantopus scaber L.	Tapak leman	Shrub	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Convolvulaceae	*Ipomoea aquatica* Forssk.	Pucuok rumpun, kangkung air	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Ipomoea reptans L. Poir	Rumpun darat	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Cucurbitaceae	*Momordica balsamina* L.	Pare hutan	Climber	Fruit	Young fruits are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Zehneria repanda (Blume) C.M.Simmons	Timun tikus	Climber	Fruit	Young fruits are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Cyatheaceae	*Cibotium barometz* (L.) J.Sm.	Paku aie	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Dennstaedtiaceae	*Pteridium aquilinum* (L.) Kuhn	Pakis bracken, Paku minyak	Herb	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Dioscoreaceae	*Dioscorea hispida* Dennst.	Gadung tanah	Climber	Tuber	Tuber peeled, cut into small pieces, immersion in salt water, boiled, and eaten as a vegetable

Fabaceae	*Archidendron bubalinum* (Jack) I.C.Nielsen	Boh kabaoe	Tree	Fruit	Young fruits are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Lathyrus oleraceus Lam.	Kaca kapa	Climber	Fruit	Young fruits are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	*Macroptilium lathyroides (*L.) Urb.	kacang selimeng	Climber	Leaf, fruit	Young leaves and fruits are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	*Psophocarpus tetragonolobus (*L.) DC.	Kecipir huten	Climber	Fruit	Young fruits are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Iridaceae	*Eleutherine bulbosa* (Mill.) Urb.	Bawang huten	Herb	Bulb, leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste. The bulbs are sliced into small pieces and added as a spice to a dish.
Lamiaceae	*Gmelina arborea* Roxb. ex Sm.	Buah belangan	Tree	Fruit	The fruits are cooked and eaten as a vegetable
	Ocimum tenuiflorum L.	Ruku	Shrub	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Limnocharitaceae	*Limnocharis flava* L.	Oen croet, Bak crout	Herb	Stem, leaf, inflorescence	The stem, leaves, and inflorescence are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Marsileaceae	*Marsilea drummondii* A.Braun	Semanggi	Creeper	Leaf	Young leaves are chopped into small pieces and boiled. Salt and spices are added to taste.
Melastomataceae	*Melastoma malabathricum* L.	Bak Temiki	Shrub	Root, leaf	Cooked and eaten as a vegetable
Menispermaceae	*Cyclea barbata* Miers	Daun tampuk tengah	Climber	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Moraceae	*Artocarpus elasticus* Reinw. ex Blume	Keulawie	Tree	Fruit	Young fruits are chopped into small pieces, boiled, and mixed with other vegetables to make curry.
	Artocarpus integer (Thunb.) Merr.	Cempedak	Tree	Fruit	Young fruits are chopped into small pieces, boiled, and mixed with other vegetables to make curry.
	Artocarpus odoratissimus Blanco	Terap	Tree	Fruit	Young fruits are chopped into small pieces, boiled, and mixed with other vegetables to make curry.
	Ficus carica L.	Buah ao tanah	Tree	Fruit	Young fruits are chopped into small pieces, boiled, and mixed with other vegetables.
	Ficus fistulosa Reinw. ex Blume	Ara	Tree	Fruit	Young fruits are chopped into small pieces, boiled, and mixed with other vegetables.
	Ficus hispida L.f.	Ara	Tree	Fruit	Young fruits are chopped into small pieces, boiled, and mixed with other vegetables.

	Ficus racemosa L.	Ara loa	Tree	Fruit	Young fruits are chopped into small pieces, boiled, and mixed with other vegetables.
Musaceae	*Ensete ventricosum* (Welw.) Cheesman	Pisang bu'e	Herb	Stem, inflorescence	Young stems and inflorescence are chopped into small pieces, boiled, and mixed with other vegetables to make curry.
	Musa acuminata Colla	Pisang bu'e	Herb	Stem, inflorescence	Young stems and inflorescence are chopped into small pieces, boiled, and mixed with other vegetables to make curry.
	Musa balbisiana Colla	Pisang hutan	Herb	Stem, inflorescence	Young stems and inflorescence are chopped into small pieces, boiled, and mixed with other vegetables to make curry.
Myrtaceae	*Syzygium polyanthum* (Wight) Walp.	Pohon salam	Tree	Leaf	Young leaves are added as a spice to a dish
Oleaceae	*Fraxinus griffithii* C.B.Clarke	kedondong pagar	Tree	Leaf	Young leaves and inflorescence are chopped into small pieces and boiled or fried in vegetable oil or mixed with other vegetables to remove the bitter taste
Passifloraceae	*Passiflora edulis* Sims	Oun kluet	Climber	Leaf	Young leaves are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
	Passiflora foetida L.	Oen sigentoet	Climber	Leaf, inflorescence	Young leaves and inflorescence are chopped into small pieces and boiled or fried in vegetable oil. Salt and spices are added to taste.
Phyllanthaceae	*Baccaurea macrocarpa* (Miq.) Müll.Arg.	Lampawuoh	Tree	Fruit	Ripe fruits are chopped into small pieces, boiled, and mixed with other vegetables to make curry.
	Breynia androgyna (L.) Chakrab. & N.P.Balakr.	Daun nasi-nasi	Herb	Leaf, fruit	Leaves and fruits are cooked and eaten as a vegetable
Piperaceae	*Peperomia pellucida (*L.) Kunth	Tumpang air	Herb	Leaf	Young leaves are chopped into small pieces and added as an item in the salad
Plantaginaceae	*Plantago major* L.	Daun sesendok	Herb	Inflorescence	Inflorescence is cooked as a vegetable or eaten raw as an item in a salad
Poaceae	*Bambusa heterostachya* (Munro) Holttum	Buluoh lomang	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Bambusa multiplex (Lour.) Raeusch. ex Schult.f.	Buluoh	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Bambusa spinosa Roxb	Buluoh duri	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Bambusa vulgaris Schrad. ex J.C.Wendl.	Trieng gampong, Bambu khoem	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Dendrocalamus asper (Schult.) Backer	Buluoh betong	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat

	Gigantochloa achmadii Widjaja	Buluoh	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Gigantochloa atroviolacea Widjaja	Rebung Wulung	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Gigantochloa atter (Hassk) Kurz	Buluoh layang	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Gigantochloa pruriens Widjaja	Buluoh	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Gigantochloa robusta Kurz	Buluoh	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Imperata cylindrica (L.) P.Beauv	Daun padang	Creeper	Root	Young roots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables
	*Neololeba atra (*Lindl.) Widjaja	Buluoh togik	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Phyllostachys aurea (André) Rivière & C.Rivière	Buloeh	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Pseudosasa japonica (Siebold & Zucc. ex Steud.) Makino ex Nakai	Bambu leumang	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Saccharum × edule Hassk.	Galagah	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Schizostachyum brachycladum (Kurz ex Munro) Kurz	Buluh leumang	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
	Schizostachyum zollingeri Steud.	Buluh	Shrub	New shoot	New shoots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables and meat
Pontederiaceae	*Pontederia crassipes* Mart.	Kalayau	Rooted hydrophyte	Root	Young roots are chopped into small pieces, boiled, or fried in vegetable oil with other vegetables
Rutaceae	*Citrus × microcarpa* Bunge	Asom kaco	Tree	Fruit	Fruits are added as spice to a dish
	Bergera koenigii L.	Temurui, Kari	Tree	Leaf	Leaves are added as spice to a dish
Talinaceae	*Talinum fruticosum* (L.) Juss	Bungo krokot	Herb	Leaf, inflorescence	Leaves and inflorescence are chopped into small pieces, cooked with other vegetables or eaten raw in a salad
Urticaceae	*Pilea melastomoides* (Poir.) Wedd.	Daun pohan	Shrub	Leaf	Leaves are eaten raw as salad
Zingiberaceae	*Etlingera elatior* (Jack) R.M.Sm.	Kincong, reboeng kala, Gincung, kecombrang	Herb	Leaf, inflorescence	Leaves and inflorescence are chopped into small pieces, cooked with other vegetables
	Hedychium gardnerianum Sheph. ex Ker Gawl.	Simameh	Herb	Rhizome	Rhizome are chopped into small pieces and added as an item in various dish

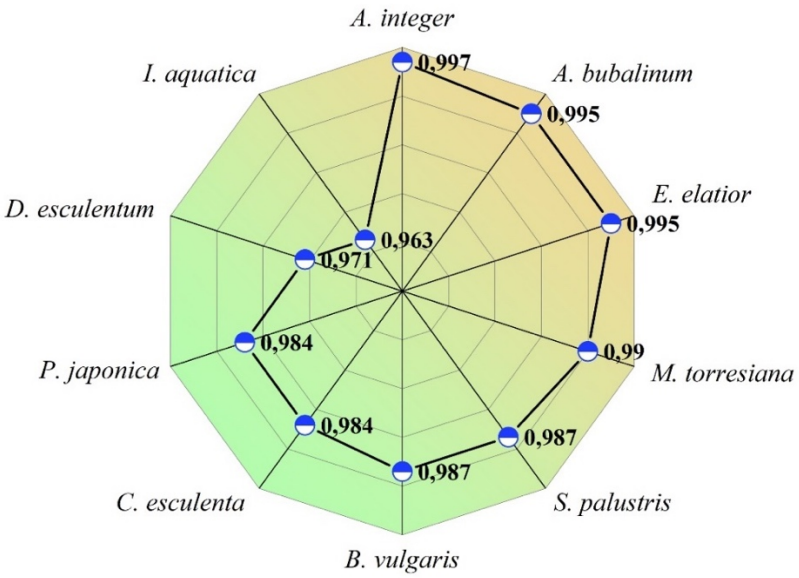

Figure 3. Relative frequency citation (RFC) of wild edible vegetable species

Main characteristics and consumption pattern of wild edible plants

The local people in the study area primarily use wild vegetables for food. The most consumed plant parts were leaves (34.7%), followed by stems (24.5%), fruits (20.5%), and flowers (9.2%), and the remaining plant parts were less than 5% (Figure 4).

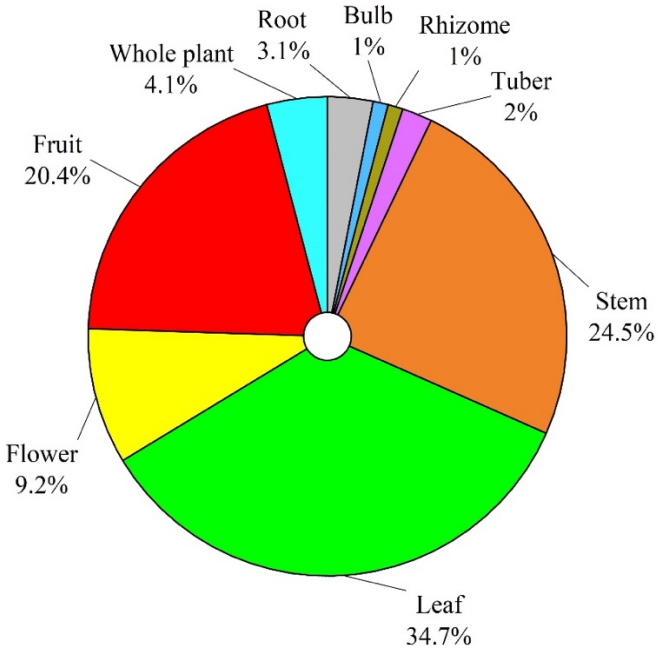

Figure 4. Plant part used

Most of the reported vegetables were consumed cooked (74), eaten raw (2), both cooked and raw (3), and 5 were added as a spice to the dish (Table 3). Several vegetables should be eaten after cooking due to the presence of some toxic compounds, i.e., *Peltandra virginica* and *Dioscorea hispida*. Most of the mentioned vegetables are collected only for self-consumption and are not sold. The top 10 most preferred wild edible vegetables by their taste quality were *Archidendron bubalinum, Artocarpus integer, Etlingera elatior, Stenochlaena palustris, Bambusa vulgaris, Macrothelypteris torresiana, Colocasia esculenta, Diplazium esculentum, Pseudosasa japonica,* and *Ipomoea aquatica*. *Archidendron bubalinum* is the most popular wild edible vegetable, preferred by the majority of respondents across all studied subdistricts (preference ranking; Table 4).

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

Species	Respondents (N=383)					Average score	Rank
	KB	KG	KT	BP	JU		
Archidendron bubalinum	4.9	4.9	4.8	4.9	4.8	4.86	1st
Artocarpus integer	4.9	4.8	4.8	4.8	4.9	4.84	2nd
Etlingera elatior	4.7	4.7	4.7	4.8	4.8	4.74	3rd
Stenochlaena palustris	4.9	4.9	4.8	4.5	4.5	4.72	4th
Bambusa vulgaris	4.7	4.7	4.8	4.7	4.6	4.70	5th
Macrothelypteris torresiana	4.7	4.6	4.7	4.7	4.7	4.68	6th
Colocasia esculenta	4.8	4.8	4.5	4.7	4.5	4.66	7th
Diplazium esculentum	4.8	4.7	4.7	4.6	4.5	4.66	8th
Pseudosasa japonica	4.8	4.7	4.6	4.5	4.5	4.62	9th
Ipomoea aquatica	4.5	4.5	4.4	4.5	4.6	4.50	10th

Note: KB = Kota Bahagia; KG = Kluet Tengah; KT = Kluet Timur; BP = Blang Pidie; JU = Jeumpa

Plant Knowledge Among Respondents

The study's findings demonstrate that respondents' knowledge of WEVs varies. The average number of species identified by respondents in each district ranged from 31.11 ± 9.21 (Kluet Tengah) to 53.15 ± 11.18 (Kota Bahagia). On average, women mentioned more WEVs than men in all study areas (mean of species: 62.12 ± 11.44 and 54.62 ± 12.38, respectively). In addition, the average number of species identified by each educational status of the respondent ranged from 15.11 ± 10.31 (Junior High School) to 52.18 ± 9.41 (Senior High School) (Table 5).

Table 5. Comparison of subgroups of respondents on their traditional knowledge of WEVs

Variable	Total respondents	The average number of WEVs identified	Statistical test	*p*-value
Sub-district			W = 62.109	0.0001
Kota Bahagia	69	53.15 ± 11.18		
Kluet Tengah	93	31.11 ± 9.21		
Kluet Timur	58	34.26 ± 10.12		
Blang Pidie	52	41.31 ± 9.13		
Jeumpa	110	49.12 ± 8.24		
Gender			χ^2 = 56.418	0.072
Men	88	54.62 ± 12.38		
Women	133	62.12 ± 11.44		
Age			W = 82.051	0.0001
15-25	31	31.08± 8.44		
26-35	46	42.21 ± 12.14		
36-45	64	52.10 ± 9.22		
46-55	59	46.12 ± 21.04		
56-65	21	62.12 ± 8.18		
Level Education			W = 66.138	0.0001
No Education	29	32.10 ± 9.25		
Elementary School	48	37.12 ± 9.44		
Junior High School	56	15.11 ± 10.31		
Senior High School	64	52.18 ± 9.41		
Higher Education	24	19.13 ± 9.23		

Species similarity among all studied districts compared was expressed by the Jaccard index. The Jaccard index indicates a level of similarity of 75% between the Kluet Timur and Kluet Tengah Districts (Figure 5).

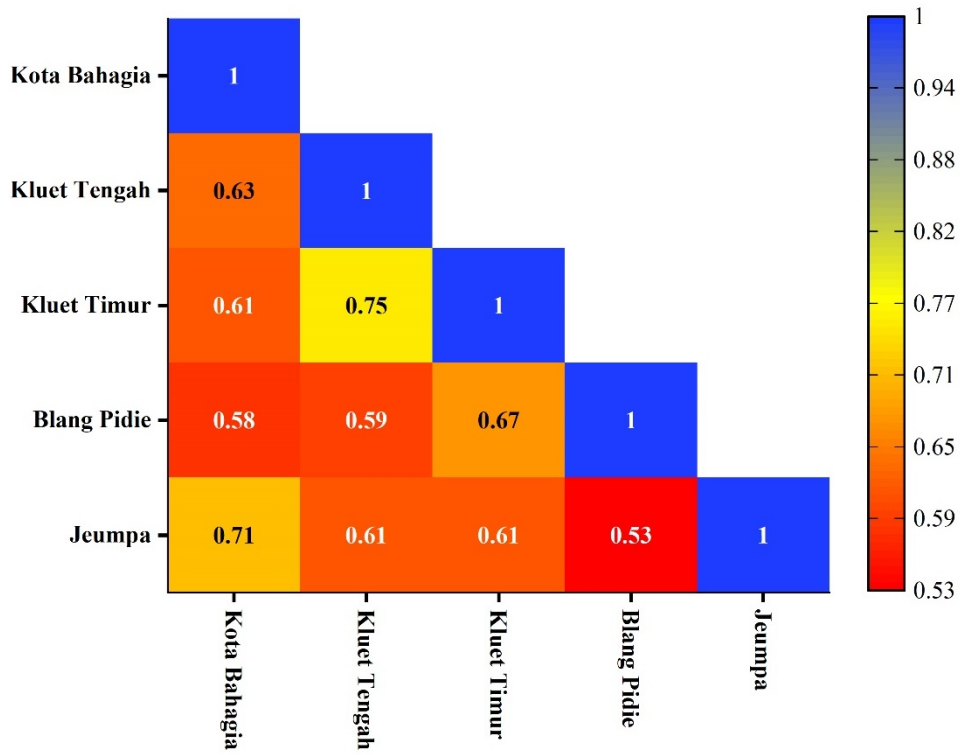

Figure. 5. The similarity of the wild vegetables among the five studied districts as well as their Jaccard Index (JI)

Discussion

A total of 86 wild species belonging to 35 families and 67 genera were documented as being consumed as vegetables by local people in the study area, which is higher than the 55 wild vegetables reported from North West Pakistan (Abbas et al. 2020), 50 species in Morocco. (Powell et al. 2014), and 10 species were reported from West Java, Indonesia (Kodir et al. 2022). However, this is less when compared to 253 wild edible vegetables reported in Sicily (Italy) (Geraci et al. 2018) and 158 species in Lebanon (Baydoun 2023). *Artocarpus integer* and *Archidendron bubalinum* were relatively common and familiar to the respondents and were extensively listed in all study villages. All of these plants are mostly harvested in farmland by local people, and certain species, such as *Diplazium esculentum*, are sold at traditional markets. Marketing wild plants plays a crucial role in efforts to preserve local knowledge loss (Paniagua-Zambrana and Tapia-Armijos 2018). Local communities can learn about the ecological, cultural, and culinary values of wild plants through appropriate marketing, allowing them to appreciate and protect biodiversity and the associated knowledge. In addition, marketing wild plants can provide economic benefits to local communities that possess unique knowledge of wild plant collecting, processing, and utilization. Marketing wild plants, therefore, serves as a bridge between economic sustainability and the preservation of local knowledge.

WEVs were discovered in the study area primarily as foods and mostly consumed both raw and cooked or further processed. Consuming wild vegetables fresh can provide considerable health benefits since they retain natural nutrients, enzymes, and a high fiber content. This plant is often added to salads to optimize its nutritional value. In addition, cooking wild vegetables also allows for the elimination of bacteria and parasites that may be present in the food. However, certain wild vegetables must be boiled before consumption to remove toxins or improve taste and texture. For example, *Peltandra virginica* leaves should be boiled to minimize oxalate levels, which can interfere with calcium absorption. Other species, such as *Dioscorea hispida*, require additional processing before being used as food. This tuber of *Dioscorea hispida* is known to contain cyanide that can cause poisoning and be deadly (Sumunar and Estiasih 2015). The poisonous component is frequently eliminated by immersing *Dioscorea hispida* tubers in salt or ash water. The immersion process in the salt solution can accelerate the dissolution of cyanide and other phytoconstituents in *Dioscorea hispida* tuber. These findings are in line with another report in East Aceh, Indonesia (Suwardi et al. 2018).

This study showed that indigenous knowledge of WEVs differed significantly between the districts, with the respondents from Kota Bahagia having more knowledge compared to other districts. Farmers predominate in the Kota Bahagia sub-district, with farming near the forest. Local communities in this area access the forest to harvest forest resources, including

WEVs. They gather WEVs as an additional source of food and income. During the discussions, respondents stated that they commonly harvest WEVs in the afternoon. These vegetables are generally consumed by themselves, but several are sold in traditional markets across the village. The study findings demonstrate that local people in the Kota Bahagia sub-district had more knowledge about WEVs than those in other study areas, as confirmed by the highest number of WEVs recorded (71 species) compared to other sub-districts. Communities in this area have an in-depth knowledge of the wild food plants that grow around them, in particular WEVs. They have learned for a long time how to properly identify, harvest, and prepare these WEVs. This demonstrates that their reliance on forest resources is very high, 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. 2021; Suwardi and Navia 2022), 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 wild edible vegetables. Respondents aged 15 to 25, the majority of whom are in Senior High School, have less traditional knowledge of WEVs 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. (2020) 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 wild edible vegetables 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 WEVs, 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 wild edible vegetables. In addition, WEVs may also be promoted by incorporating WEVs knowledge into local subjects in schools.

Conclusions and recommendations

A total of 86 wild species belonging to 35 families and 67 genera were documented as being consumed as vegetables by local people in the study area. Despite the fact that the study discovered a high diversity of wild edible vegetables, local people in Kluet Tengah only used an average of 31.11 ± 9.21 species out of 57 species recorded. As a result, future studies on potential wild edible vegetables, including nutritional value, is critical to promoting and conserving wild edible vegetables. The study also discovered that younger generations have less indigenous knowledge than older generations, recommending that wild edible vegetables knowledge be incorporated into educational curricula.

Declarations

Ethical approval and consent to participate: Permission was taken from the head of the subdistrict of Kota Bahagia, Kluet Tengah, Kluet Timur, Blang Pidie, and Jeumpabefore data collection. Oral agreements were obtained from local respondents and all field data were collected through their oral approval.

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

Consent for publication: Not applicable.

Conflict of interests: The authors declare no competing interests.

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

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