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Diversity and utilization of vegetables and spices by coastal community in East Aceh, Indonesia

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Abstract. *Nursamsu, Susantini E, Yuliani, Nurhafidhah. 2025. Diversity and utilization of vegetables and spices by coastal community in East Aceh, Indonesia. Biodiversitas 26: 837-850.* Food security a major concern in many countries, particularly in coastal regions potentially impacted by climate change and natural hazards. Food security correlates with the loss of traditional culinary expertise, particularly among the younger generation. Therefore, this research aimed to explore and document traditional knowledge about various plants used as vegetables and spice by a coastal community in East Aceh District, Aceh Province, Indonesia. Ethnobotanical knowledge data was collected in five villages using field surveys and semi-structured interviews. A total of 92 plant taxa from 41 families are used as vegetables and spices by coastal community in East Aceh, emphasizing their importance in traditional food and local culture. The Cucurbitaceae family is the family with the largest use, comprising 10 taxa which show high protein and dietary fiber content. *Cocos nucifera* and *Nypa fruticans* have the greatest Use Value (UV), with *C. nucifera* ranking first on the Index of Cultural Significance (ICS). Furthermore, the vegetables and spices are collected from cultivated plants (77.2%) and those grow wild (22.8%), showing a relatively high community dependence on natural ecosystem. The most widely used plant parts are fruits (42.5%) and leaves (25.7%). In conclusion, this research showed the importance of plants for food security, health, and cultural preservation, with sustainable methods such as agroecology to ensure their continuing use.

Keywords: Coastal, diversity, food security, spices, vegetables

INTRODUCTION

Coastal communities are categorized as groups of individuals living in coastal regions whose economic livelihoods depend on the use of marine and land-based natural resources (Rideng et al. 2021). Food is a basic need for human survival, serving as essential source of energy and nutrients, and has social, cultural, and economic roles (Blancas et al. 2013; Nunes et al. 2013). Food security is a global issue, being a major concern for many countries, particularly in coastal regions which are vulnerable to climate change and unpredictable natural conditions. Beside the high dependency of coastal community on marine resources, such as fisheries, terrestrial natural resources are also important for their livelihood, such as traditional vegetables and spices (Neudeck et al. 2012; Amente 2017; Aryal et al. 2018). Plants have long been used in various ways, including as a food source, sustenance, and livestock feed (Malini et al. 2017; Elfrida et al. 2021; Ivanova et al. 2021; Saudah et al. 2021a,b; Suwardi et al. 2021; Nursamsu et al. 2024). Furthermore, plants are essential for the social, economic, and cultural development of community (Sutrisno et al. 2021).

In Indonesia, coastal regions play an important role in maintaining national food security. Aceh is one of Indonesia's provinces with a long coastline and rich cultural diversity, yet it faces challenge in maintaining food security for coastal communities (Putri et al. 2019). To address this challenge, the use of local biodiversity¸ particularly vegetables and spices, has been important to maintain food security (Agesti et al. 2023). Factors such as geographic location and community history influence the culture, dietary habits, types of dishes, cooking methods, and culinary characteristics (Yaris and Ozkaya 2015; Nurainas et al. 2022). Traditional vegetables and spices in Aceh's coastal regions have long been an integral part of the local community (Rahman 2018; Saudah et al. 2021b; Iskandar et al. 2023). These plants serve as a rich source of nutrients, with significant cultural and economic value (Amalia and Marta 2018). The use of traditional vegetables and spices in the daily lives of Aceh's coastal community shows local wisdom that has been passed down through generations (Cencen and Berk 2014). This diversity of plants contributes to food security and the maintenance of ecosystem balance, thereby preserving local wisdom (Amalia and Marta 2018; Agesti et al. 2023).

Beside the utilization aspect, local wisdom also includes knowledge of how to cultivate, process, and preserve vegetables as well as spices to ensure their availability throughout the year, particularly during difficult seasons. This is essential because coastal regions are often vulnerable to natural disasters such as floods, tidal waves, and extreme weather, which can disrupt food production. However, changes in community consumption patterns to favor fast food have caused a decrease in local knowledge about vegetables and spices in traditional dishes. This leads to the loss of traditional culinary expertise over time, particularly among the younger generation (Hidayat 2017; Sutrisno et al. 2021). Traditional vegetables and spices are a valuable part of local cultural history that must be preserved for culinary purposes and the provision of information about a tribe identity, lifestyle, food, and authenticity (Karaca and Karacaoglu 2016).

Aceh culinary is unique which possess one of a kind tastes that is distinguishable from other territorial cuisines in Indonesia. This uniqueness lies within the mix of neighborhood flavors, ordinary seasonings, and conventional cooking procedures that reflect Aceh's wealthy social and cultural legacy (Nursamsu et al. 2024). The wide range of flavors and seasonings is certainly one of the most notable features that shapes the richness of Aceh's culinary flavors. Ingredients, such as cloves, cardamom, cinnamon, pepper, and *kecombrang*, commonly alluded to in Aceh as "*bak kala*", give a unique smell and flavor, and have a profound verifiable cultural esteem (Saudah et al. 2022; Puspa et al. 2024).

Therefore, this research aimed to explore and document traditional knowledge about vegetables and spices of a coastal community in East Aceh District, Aceh Province, Indonesia, which play a significant role in the community's daily life and food security. Documenting this knowledge provides a significant contribution to the understanding of sustainable food sources and promotes the conservation of local plant species that are important to cultural heritage. The results provide important information on the understanding of plant species, usage practices, and surrounding cultural context, serving as the basis for future conservation efforts and research.

MATERIALS AND METHODS

Study period and area

This research was conducted in September 2024 at five villages located in East Aceh District, Aceh, Indonesia, namely Kuala Idi, Gampong Aceh, Blang Geulumpang, Ulee Blang, and Titi Baro (Figure 1). These villages are situated between the coordinates 4°09′21.08"-5°06′02.16"N and 97°15′22.07"-97°34′47.22"E, with elevations ranging from 0 to 240 meters above sea level (m asl) and slopes of 1 to 5 degrees. The total area of East Aceh District is 6,040.60 km², with a population of 449,796 people, comprising 226,269 males and 223,527 females, primarily work as fishermen (The Central Bureau of Statistics of East Aceh District 2024). The region is characterized by a humid tropical climate with monthly rainfall from April to December ranges from 26.60 mm to 342.70 mm, and average temperatures from 25-32°C, and these factors contribute to the region's natural richness. The uniqueness of this research location lies in the geographical position, which spans coastal and mountainous regions, leading to a rich biodiversity in terms of both flora and fauna (Nursamsu et al. 2024). The abundance of food crops including vegetables and spices is significant, although these resources have not been fully utilized (Suwardi et al. 2021). There is also a decreasing interest in learning about local knowledge, which might lead to potential loss of traditional wisdom (Suwardi et al. 2021).

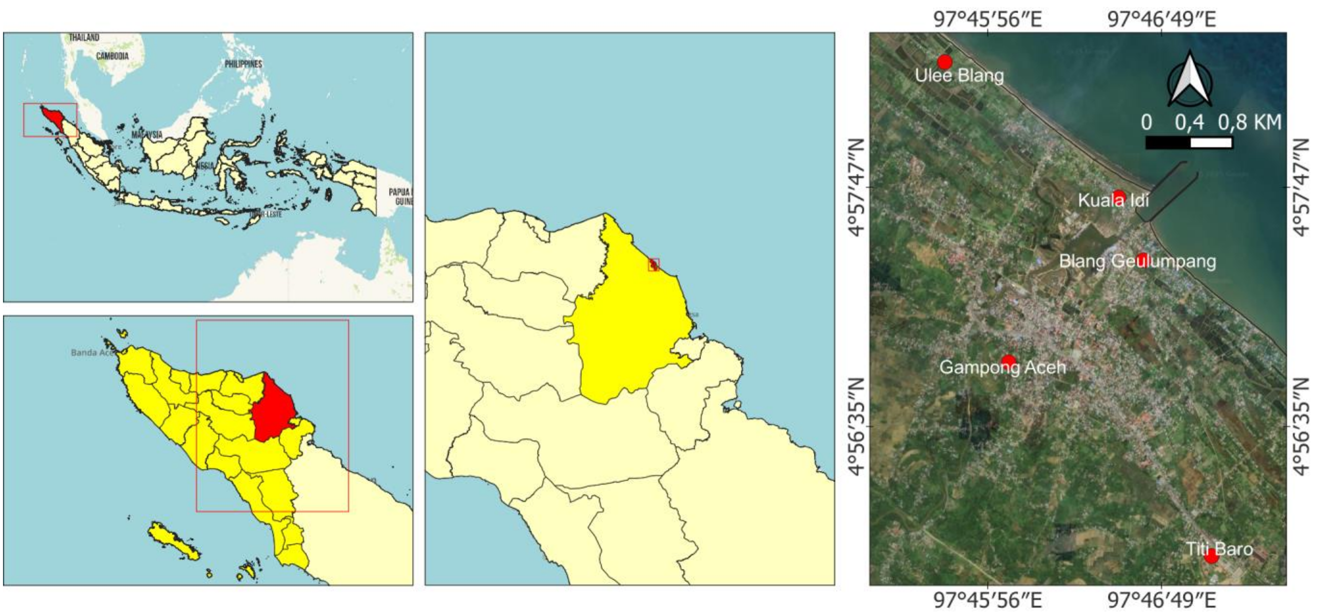

Figure 1. Map of study area in five villages: Kuala Idi, Gampong Aceh, Blang Geulumpang, Ulee Blang, and Titi Baro in East Aceh District, Aceh Province, Indonesia

Procedures

The initial step of this research included gathering information on the diversity of vegetables and spices as well as their use by the community through field surveys comprising 100 key respondents from five villages and 20 key respondents, each were considered knowledgeable about indigenous foods and spices in East Aceh District (Table 1). The respondents were selected using purposive snowball sampling (Martin 1995; Albuquerque et al. 2014) and semi-structured interviews (Bernard 2017). The unique and diverse responses from randomly selected respondents made the data gathered both unique and interesting. The purpose of selection was to ensure that comprehensive and useful data were provided for the research team and field observers, allowing the use of information in the future (Bender et al. 2014; Espinoza-Pérez et al. 2021). The respondents were predominantly of Acehnese ethnicity, ranging in age from 15 to over 65 years (Table 1). The selection process mainly focused on female respondents who were generally responsible for cooking, making their information more extensive.

All interviews were conducted in native language (primarily Acehnese) through a native translator, and the data were later translated into English (Navia et al. 2022). The interviews used a questionnaire covering the types of plants, local names, parts, processing methods, and their use as vegetables or spices in traditional Acehnese dishes by coastal community. This was particularly conducted to obtain in-depth information on the local use of plants by the community. During the interviews, respondents were asked to describe the types of plants and their local names, showing the uniqueness and local wisdom. Furthermore, respondents were asked to explain the plant's part majorly used, such as leaves, fruits, roots, or seeds, and the processing method. The questionnaire also explored the frequency of use, sources of the plants, and associated challenges such as availability or complicated processing methods. The interviews collected technical information about the plants and showed their important role in the social and cultural lives of the community, providing a foundation for further research or the management of local resources (Yineger et al. 2007; Heinrich et al. 2009; Lulekal et al. 2014). Plant identification was carried out directly in the field (Hedberg et al. 1989; et al. 2003). The plant names were updated based on the food used by the local community, according to traditional knowledge (López-Patiño et al. 2022) and documented through photographs. The identified plants were matched using an online plant database (https://powo.science.kew.org/) from the Royal Botanic Gardens Kew (2024).

Data analysis

This research applied both qualitative and quantitative descriptive analysis methods. Qualitative analysis was conducted by categorizing interview data based on plant types, parts used, and their daily applications. The results were presented visually through a cord diagram, designed to be aesthetically appealing and engaging. Subsequently, the data were analyzed quantitatively by calculating the Use Value (UV) to assess the utility of plants in a specific region. The Relative Frequency of Citation (RFC) was applied to determine which plants were the most popular. Index of Cultural Significance (ICS) measures the importance of a species within a cultural context. Furthermore, Cultural Food Significance Index (CFSI) was used to evaluate the importance of food plants in the cultural context, particularly in relation to their traditional value and use as a source of nutrition.

Use Value (UV)

UV is a quantitative index used to evaluate the relative usefulness of a plant in a particular region. It is often used to identify which plants offer the greatest benefits and determine the most valuable species. The UV is calculated using the following formula:

$$UV = U/N$$

Where, U represents the number of reports mentioning the use of the species, and N is the number of respondents. A higher UV shows that the plant species is more frequently used in daily life (Tardio and Pardo-de-Santayana 2008).

Relative Frequency of Citation (RFC)

RFC was developed by Tardio and Pardo-de-Santayana (2008), which showed the local importance of each species. Moreover, higher RFC value showed more popularity of plant, as obtained from the equation:

$$RFC = FC/N$$

Where, FC is the number of respondents who mentioned the species and N is the number of respondents (Vitalini et al. 2013).

This parameter is useful to inform how frequently a species is known or used by the community, providing insights into cultural significance, medicinal importance, and ecological value. A higher RFC shows that the species is well-known or frequently used by respondents, which may reflect its importance in local traditions or practices. It is highly useful for identifying key species within traditional knowledge systems and for prioritizing conservation efforts.

Index of Cultural Significance (ICS)

ICS refers to various investigations that assess the importance of a species within a cultural context. This method is often used in ethnobotanical research to evaluate how extensively a plant is used, the intensity of usage, practical applications, and significance in the local culture. The formula for calculating ICS, as proposed by Turner (1988), is as follows:

$$ICS = \Sigma (Q \times I \times U \times C)$$

Where, Q represents the number of records reporting the use of the species, I refers to the intensity of the species' use, U is the level of usefulness of the plant in daily life, whether as food, medicine, or other materials, and C denotes the cultural importance of the plant. The Index of Cultural Significance (ICS) is used to interpret the importance of each plant species to the community, considering aspects such as quality, intensity, and uniqueness of use (Eni et al. 2019).

Cultural Food Significance Index (CFSI)

The CFSI, proposed by Pieroni (2001), is specifically designed to evaluate the cultural importance of edible plants. The formula for calculating CFSI is as follows:

$$CFSI = QI \times AI \times FUI \times PUI \times MFFI \times TSAI \times FMRI \times 10^{-2}$$

The factors include: QI: the frequency of citation; AI: the availability of the plant; FUI: the frequency of its use; PUI: the parts of the plant that are utilized; MFFI: the multifunctional use of the plant for food purposes; TSAI: the taste appreciation score; FMRI: the food-medicinal role of the plant (Turner 1988; Stoffle et al. 1990; Pieroni 2001). CFSI is used to assess the significance of food plants within a cultural context, particularly regarding their traditional value and role as a source of nutrition.

RESULTS AND DISCUSSION

Socio-demographic characteristics

A total of 100 respondents were interviewed during the research conducted in five villages in East Aceh District, Aceh, Indonesia. The respondents consisted of 22 males (22%) and 78 females (78%), aged between 15 and over 65 years (Table 1). The majority had completed junior high school (33%), followed by Junior High School (33%), Senior High School (30%), Elementary School (18%), No Education (12%), and Higher Education (7%). The diversity in background and education levels caused a wide range of responses, making the data unique and varied, as shown in Table 1.

Types of vegetables and spices

A total of 92 taxa of vegetables and spices from 41 families were recorded as being used in traditional Acehnese cuisine by coastal community in East Aceh District, Aceh, Indonesia. Cucurbitaceae was the most often used family, accounting for 10 of the 92 taxa documented in the research region. This was because members of the Cucurbitaceae family were high in protein and dietary fiber (Romo-Tovar et al. 2024). According to the respondents, in addition to the fruits and leaves used for food, the seeds were used as therapeutic components due to the presence of significant elements such as minerals, copper, phosphorus, zinc, and others (Rolnik and Olas 2020). Members of this family also contained a high content of carotenoids and pectin. Consuming rich fiber meals could assist diabetics in maintaining their blood sugar levels and lessen the need for insulin (Yiblet 2023). According to the knowledge of respondents, the Cucurbitaceae family was frequently used as an ingredient in a variety of meals, particularly boiled food and curry. The extensive knowledge was further affected by versatile usage as food, medicine, economic sources, and animal feed (Suwardi et al. 2021) (Table 2, Figure 2).

The species identified in this research were higher compared to previous studies across Indonesia. Syamsuardi et al. (2022) showed that the coastal Aneuk Jamee ethnic group in South Aceh only documented 52 taxa of vegetables and spices in their regional cuisine. Similarly, the Dayak ethnic group in Kalimantan used 39 taxa (Julung et al. 2021), while the Madurese in East Java applied 35 taxa as vegetables and spices (Novita et al. 2023). The Batak Karo ethnic group in North Sumatra used approximately 85 taxa (Silalahi and Nisyawati, 2018), and the Malay ethnic group in Riau applied 76 taxa (Susandarini et al. 2021). Additionally, the Sundanese in West Java used 65 taxa (Iskandar et al. 2023). These data showed the rich biodiversity of food plants, particularly vegetables and spices, which supported the preservation of diverse and important traditional knowledge. The large number of species found showed that the vegetation in the research region served as a reservoir for various types of vegetables and spices (Zemede et al. 2024).

Table 1. Demographic characteristics of respondents in East Aceh District, Aceh Province, Indonesia

Parameter	Specification	Frequency	Percentage (%)
Gender	Male	22	22
	Female	78	78
Age (years)	15-25	8	8.2
	26-35	12	12.2
	36-45	18	18.4
	46-55	26	26.5
	56-65	20	20.4
	>65	14	14.3
Education	No Schooling	12	12
	Elementary School	18	18
	Junior High School	33	33
	Senior High School	30	30
	University	7	7

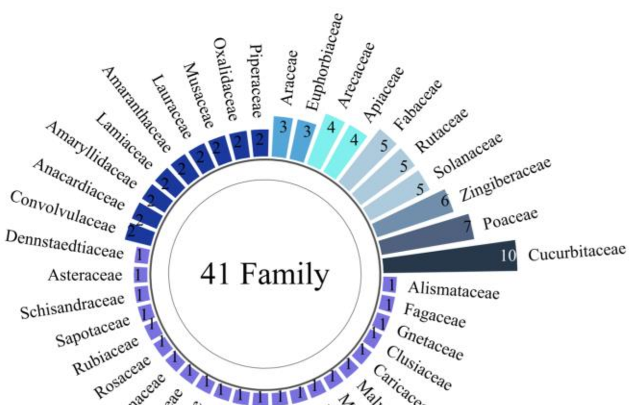

Figure 2. The family of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

Table 2. Vegetables and spices used by coastal community in East Aceh District, Aceh Province, Indonesia

Species name	Local name	Parts used	Plant habitus	Mode of cultivation	Benefits	UV	ICS
Alismataceae							
Ludwigia flava	*Genjer*	Leaf	Herb	Wild	Food	0.63	25.8
Amaranthaceae							
Amaranthus hybridus	*Bayam*	Leaf	Herb	Cultivated	Food, economy, culture, medicine, food coloring	0.77	55.4
Amaranthus tricolor	*Bayem mirah*	Leaf	Herb	Cultivated	Food, economy, culture, medicine, food coloring	0.68	52.4
Amaryllidaceae							
Allium cepa	*Bawang mirah*	Tuber	Herb	Cultivated	Food, economy, culture, medicine	0.94	3.6
Allium sativum	*Bawang puteh*	Tuber	Herb	Cultivated	Food, economy, culture, medicine	0.62	132.7
Anacardiaceae							
Madhuca foetida	*Bak mancang*	Fruit	Tree	Cultivated	Food, economy, medicine, building materials, agricultural tools	0.62	127.7
Scoparia dulcis	*Kerundong*	Fruit	Tree	Cultivated	Food, medicine, building materials, agricultural tools	0.63	9
Annonaceae							
Annona muricata	*Drien landa*	Fruit	Tree	Cultivated	Food, economy, culture, medicine	0.65	10.6
Apiaceae							
Foeniculum vulgare	*Adas*	Seed	Herb	Cultivated	Food, economy, culture, medicine	0.63	22.8
Cuminum cyminum	*Jintan*	Seed	Herb	Cultivated	Food, economy, culture, medicine	0.64	46.8
Coriandrum sativum	*Ketumbar*	Seed	Herb	Cultivated	Food, economy, culture, medicine	0.7	25.8
Centella asiatica	*Pegaga*	Leaf	Herb	Cultivated	Food, medicine	0.56	22.8
Araceae							
Alocasia brisbanensis	*Empeuk kemahang*	Fruit	Herb	Wild	Food	0.55	74.4
Alocasia macrorrhizos	*Empeuk*	Tuber, Stem	Herb	Wild	Food, economy, culture, medicine	0.65	41.1
Colocasia esculenta	*Empeuk mirah*	Tuber, Stem	Herb	Cultivated	Food, economy, culture, medicine	0.77	34.2
Arecaceae							
Cocos nucifera	*Bak U*	Fruit, Stem core	Tree	Cultivated	Food, drink, economy, medicine, building materials, agricultural tools, handicrafts	0.98	144.5
Areca catechu	*Pineung*	Fruit	Palm	Cultivated	Food, economy, culture, medicine	0.79	27.2
Arenga pinnata	*Bak Ijok*	Fruit	Palm	Wild	Food, drink, economy, culture, medicine, agricultural tools, handicrafts	0.63	21
Nypa fruticans	*Nipah*	Fruit	Palm	Wild	Food, economy, culture, medicine, agricultural tools, handicrafts	0.96	6.3
Aspleniaceae							
Diplazium esculentum	*Ouen paku*	Leaf, Stem	Herb	Wild	Food, economy, medicine	0.69	49.2
Asteraceae							
Eleutheranthera scaber	*Tapak leman*	Leaf	Shrub	Cultivated	Food, culture, animal feed	0.64	29.2
Bromeliaceae							
Ananas comosus	*Aneuh*	Fruit	Herb	Cultivated	Food, drink, economy, culture, medicine	0.57	32.6
Caricaceae							
Carica papaya	*Bak peutek*	Leaf, Fruit, Flower	Herb	Cultivated	Food, drink, economy, culture, medicine, animal feed	0.61	22.4
Clusiaceae							
Garcinia atroviridis	*Boh asam gelugur*	Fruit	Tree	Cultivated	Food, economy, culture, medicine, building materials, agricultural tools	0.58	28.1
Convolvulaceae							
Ipomoea aquatica	*Rumpon*	Leaf, Stem	Climbing	Cultivated	Food, economy, culture, medicine, animal feed	0.75	47.1
Ipomoea aquatica	*Rumpon mirah*	Leaf, Stem	Climbing	Wild	Food, economy, culture, medicine, animal feed	0.69	9.8
Cucurbitaceae							
Benincasa hispida	*Kundur*	Fruit	Climbing	Cultivated	Food	0.71	98.4
Sicyos edulis	*Labu jipang*	Fruit	Climbing	Cultivated	Food, economy, culture, medicine, animal feed	0.57	68.4
Citrullus lanatus	*Timon brouk*	Fruit	Climbing	Cultivated	Food, drink, economy, culture, medicine	0.96	67.6
Cucumis melo var. *reticulatus*	*Timon gapu*	Fruit	Climbing	Cultivated	Food, drink, economy, culture, medicine	0.59	22.8

Cucumis melo	*Melon*	Fruit	Climbing	Cultivated	Food, drink, economy, culture, medicine	0.69	64.4
Cucumis sativus	*Timon*	Fruit	Climbing	Cultivated	Food, drink, economy, culture, medicine	0.59	24.8
Lagenaria siceraria	*Labu aie*	Fruit	Climbing	Cultivated	Food, economy, culture, medicine	0.63	49.2
Luffa acutangula	*Peria*	Fruit	Climbing	Cultivated	Food, medicine	0.84	41.2
Cucurbita moschata	*Labu kuneng*	Fruit, Leaf	Climbing	Cultivated	Food, economy, culture, medicine	0.83	22.8
Cucurbita pepo	*Labu maneh*	Fruit, Leaf	Climbing	Cultivated	Food, economy, medicine	0.65	62.4
Dennstaedtiaceae							
Pteridium aquilinum	*Ouen paku minyeuk*	Leaf, Stem	Herb	Wild	Food, economy, medicine	0.63	56.1
Euphorbiaceae							
Aleurites moluccanus	*Kemiri*	Seed	Shrub	Cultivated	Food, economy, culture, medicine	0.61	23
Manihot esculenta	*Ouen ubi*	Leaf, Tuber	Shrub	Cultivated	Food, economy, medicine, animal feed	0.61	6.3
Manihot esculenta	*Ouen ubi kriting*	Leaf	Shrub	Cultivated	Food, economy, culture, animal feed	0.61	43.2
Fabaceae							
Vigna unguiculata subsp. unguiculata	*Kacang panyang*	Fruit, Leaf	Climbing	Cultivated	Food, economy, culture	0.65	43.2
Vigna angularis	*Kacang mirah*	Fruit, Leaf	Climbing	Cultivated	Food, economy	0.66	33.2
Phaseolus vulgaris	*Kacang buncis*	Fruit, Leaf	Climbing	Cultivated	Food, economy	0.62	23.8
Parkia speciosa	*Patai*	Seed	Tree	Cultivated	Food, economy, culture, medicine, building materials, agricultural tools	0.61	28.1
Archidendron pauciflorum	*Jengkol*	Fruit	Tree	Cultivated	Food, economy, culture, medicine, building materials, agricultural tools	0.52	47.1
Fagaceae							
Ficus insipida	*Bak ara*	Fruit	Tree	Wild	Food, medicine	0.61	9.8
Gnetaceae							
Gnetum gnemon	*Muling*	Fruit	Tree	Cultivated	Food, economy, culture, medicine, agricultural tools, animal feed	0.82	98.4
Lamiaceae							
Ocimum tenuiflorum	*Ouen ruku*	Leaf	Shrub	Wild	Food, culture, medicine	0.67	26.4
Ocimum basilicum	*Ouen semanggi*	Leaf	Shrub	Cultivated	Food, economy, culture, medicine	0.61	21.2
Lauraceae							
Cinnamomum verum	*Kulet mameh*	Bark	Tree	Wild	Food, economy, culture, medicine	0.83	25.2
Persea americana	*Pokat*	Fruit	Tree	Cultivated	Food, drink, economy, culture, medicine, agricultural tools	0.71	1.2
Malvaceae							
Durio zibethinus	*Drien*	Fruit	Tree	Cultivated	Food, economy, culture, medicine, building materials, agricultural tools	0.64	24.6
Melastomataceae							
Melastoma malabathricum	*Senggani*	Leaf	Herb	Wild	Food, medicine	0.62	12.8
Moraceae							
Artocarpus heterophyllus	*Boh panah*	Fruit	Tree	Cultivated	Food, economy, culture, medicine, building materials, agricultural tools, animal feed	0.63	15.2
Musaceae							
Musa balbisiana	*Bak pisang uten*	Stem core	Herb	Wild	Food	0.84	37.8
Musa×paradisiaca	*Bak pisang*	Fruit, Stem core, Banana heart	Herb	Wild	Food, economy, culture, medicine	0.7	24.4
Myristicaceae							
Myristica fragrans	*Pala*	Fruit	Tree	Cultivated	Food, economy, culture, medicine, building materials, agricultural tools	0.65	64.8
Myrtaceae							
Psidium guajava	*Jambe kluto*	Fruit	Tree	Cultivated	Food, drink, economy, culture, medicine, agricultural tools	0.63	23.2
Nyctaginaceae							
Boerhavia diffusa	*Rukut*	Leaf	Herb	Wild	Food	0.61	9.8
Oxalidaceae							
Averrhoa bilimbi	*Bak geulimeng*	Fruit	Tree	Cultivated	Food, economy, culture, medicine, agricultural tools	0.95	37.2
Averrhoa carambola	*Geulimeng sago*	Fruit	Tree	Cultivated	Food, drink, economy, culture, medicine, agricultural tools	0.61	39.2

Pandanaceae							
Pandanus amaryllifolius	*Sike musang*	Leaf	Herb	Cultivated	Food, drink, culture, medicine, food coloring	0.66	25.8
Phyllanthaceae							
Sauropus androgyna	*Ouen nasi-nasi*	Leaf	Shrub	Wild	Food	0.67	35.2
Piperaceae							
Piper nigrum	*Lada*	Fruit	Herb	Cultivated	Food, economy, culture, medicine	0.63	73.6
Piper betle	*Ranup*	Leaf	Climbing	Cultivated	Food, economy, culture, medicine	0.61	79.8
Poaceae							
Schizostachyum brachycladum	*Rebong*	Stem	Grass	Wild	Food, economy, culture, medicine	0.55	73.8
Dendrocalamus asper	*Rebong beutong*	Stem	Grass	Wild	Food, culture, medicine	0.91	64.6
Cymbopogon citratus	*Bak areu*	Stem	Herb	Cultivated	Food, economy, culture, medicine	0.95	71.4
Zea mays	*Jagong*	Seed	Grass	Cultivated	Food, economy, culture, medicine, animal feed	0.63	37.6
Oryza sativa	*Pade*	Seed	Grass	Cultivated	Food, economy, culture, medicine	0.96	65.7
Oryza sativa var. *glutinosa*	*Pade leukat*	Seed	Grass	Cultivated	Food, economy, culture, medicine	0.7	52.8
Saccharum officinarum	*Tube beutong*	Stem	Shrub	Cultivated	Food, drink, economy, culture, medicine	0.65	59.1
Rosaceae							
Rubus moluccanus	*Cengkenir*	Fruit	Herb	Cultivated	Food	0.63	43.4
Rubiaceae							
Coffea	*Kupi*	Leaf, Seed	Shrub	Cultivated	Food, drink, economy, culture, medicine, agricultural tools	0.61	37.2
Rutaceae							
Bergera koenigii	*Ouen kari*	Leaf	Shrub	Wild	Food	0.59	40.2
Citrus×aurantiifolia	*Asam gapeuh*	Fruit	Tree	Cultivated	Food, drink, economy, culture, medicine, agricultural tools	0.52	49.2
Citrus×amblycarpa	*Sundee*	Fruit	Tree	Cultivated	Food, culture, medicine	0.61	41.2
Citrus maxima	*Asam tangkih*	Fruit	Tree	Cultivated	Food, economy, culture, medicine, agricultural tools	0.82	22.8
Citrus hystrix	*Asam limo purot*	Leaf	Shrub	Cultivated	Food, economy, culture, medicine	0.67	62.4
Sapotaceae							
Manilkara zapota	*Sawoh*	Fruit	Tree	Cultivated	Food, drink, economy, medicine, agricultural tools	0.61	56.1
Schisandraceae							
Illicium verum	*Bungong lawang*	Fruit	Tree	Cultivated	Food, economy, culture, medicine	0.83	23
Solanaceae							
Solanum stramoniifolium var. *stramoniifolium*	*Trung rimbang*	Fruit	Shrub	Wild	Food, economy, medicine	0.71	6.3
Capsicum annuum	*Campli rayeuk*	Fruit	Shrub	Cultivated	Food, economy, culture, medicine	0.64	43.2
Capsicum frutescens	*Campli cut*	Fruit	Shrub	Cultivated	Food, economy, culture, medicine	0.62	43.2
Solanum lycopersicum	*Tomat*	Fruit	Herb	Cultivated	Food, drink, economy, culture, medicine	0.63	33.2
Solanum melongena	*Trung*	Fruit	Shrub	Cultivated	Food, economy, culture, medicine	0.84	23.8
Zingiberaceae							
Etlingera elatior	*Bak kala*	Flower, Fruit	Herb	Wild	Food, economy, culture, medicine	0.7	28.1
Curcuma longa	*Kunyet*	Rhizome, Leaf	Herb	Cultivated	Food, drink, economy, culture, medicine, food coloring	0.65	47.1
Zingiber officinale	*Halia*	Rhizome	Herb	Cultivated	Food, drink, economy, culture, medicine	0.63	9.8
Alpinia galanga	*Lengkuweh*	Rhizome	Herb	Cultivated	Food, drink, economy, culture, medicine	0.61	98.4
Kaempferia galanga	*Alia*	Rhizome	Herb	Cultivated	Food, economy, culture, medicine	0.52	26.4
Elettaria cardamomum	*Kapulaga*	Rhizome	Herb	Cultivated	Food, economy	0.61	21.2

However, biodiversity varies across different regions, depending on environmental conditions, the availability of natural resources, as well as local cultural practices and traditions. Factors such as soil type, climate, and local knowledge about plant use also influence the composition of food plant species, including vegetables and spices. For example, regions with wetter climates have more tropical fruit plants, while drier areas cultivate more drought-resistant plants (Bersamin et al. 2021). The existence and sustainability of food plants, particularly wild species, must be carefully monitored due to the risk of extinction caused by the rapid rate of deforestation (Singh and Yan 2021).

Habitus of vegetable and spices

The habitus of food plants refers to the growth form, which varies significantly (Duguma 2020). Based on the data obtained, the variation of plant types shows that herbs (30%) are the most dominant, followed by trees (23.8%). Climber plants (20%) make a significant contribution, while shrubs (16.3%) also represent a considerable proportion. Grasses (6.3%) and palms (3.8%) show smaller percentages, indicating the diversity of vegetation types (Figure 3).

The diversity of plant types shows a rich ecosystem, where each category plays a different role in the environment (Li et al. 2022). The dominance of herb species shows their importance in providing ground cover, supporting soil stability, and serving as a food source for various organisms. Trees, with a substantial percentage, make significant contributions to carbon absorption, provide shade, and create habitats for wildlife. Climber plants add vertical structure to the ecosystem, allowing for increased light capture and biodiversity. Although less abundant, shrubs offer important shelter and food for many species, with the smaller percentages of grasses and palms indicating specific ecological niches. This distribution emphasizes the interconnectedness of plant groups as well as the contributions to a balanced and thriving ecosystem (Losapio 2023).

Mode of cultivation of vegetables and spices

Cultivated plants were more dominant, accounting for 77.2% (71 taxa), compared to the wild plants at 22.8% (21 taxa). Cultivated plants are purposively grown and developed for specified purposes, such as food, commodities, and others. These comprise food plants such as coconut, rice, and corn for consumption, horticulture including vegetables and fruits for fresh consumption, and commercially valuable plantations consisting of oil palm and rubber. Furthermore, therapeutic plants are grown for medicinal purposes and are used as industrial raw materials. Wild plants are developed naturally without human interference and are classified into three types, namely pioneer plants, which thrive in disturbed areas. Endemic plants are only found in certain places, while invasive plants expand swiftly and destroy local ecosystems. Edible leafy wild plants are high in nutrients and antioxidants, showing unique organoleptic properties that are preferred by consumers (Disciglio et al. 2017; Chrysargyris et al. 2023). Cultivated plants are regulated for higher output, while wild plants grow spontaneously (Ensslin and Godefroid S. 2020) (Figure 4).

The status of wild and cultivated plants shows the differences in sustainability and use between naturally growing plants and cultivated types. Wild plants often grow in their natural habitats without human intervention, adapting to surroundings and providing significant ecological value as guardians of biodiversity balance and sources of food with natural medicinal benefits for local fauna. However, their status is often threatened by environmental changes, land use conversion, human activities, and habitat quality.

Cultivated plants are developed through human intervention, aimed at improving productivity, quality, or resilience to specific environmental conditions. This cultivation allows for a more planned fulfillment of food and industrial needs. But, cultivation might pose several risks, such as decreased genetic diversity and dependence on agricultural inputs including fertilizers and pesticides. The status of both types shows the importance of maintaining a balance between the use of wild and cultivated plants, as well as implementing sustainable practices that consider conservation, food independence, and ecosystem balance. The cultivation of food plants, both cultivated and wild, found in forests should also be pursued for commercial purposes. This is because the cultivation of food plants in forests does not change the function as a provider of ecosystem services (Fitriyani et al. 2020).

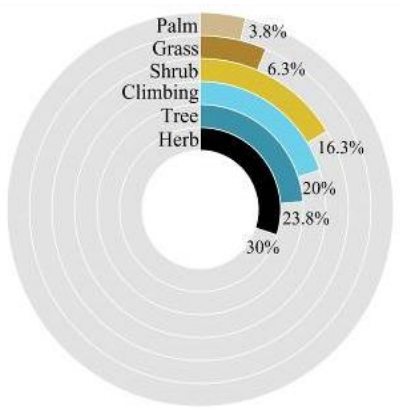

Figure 3. The habitus of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

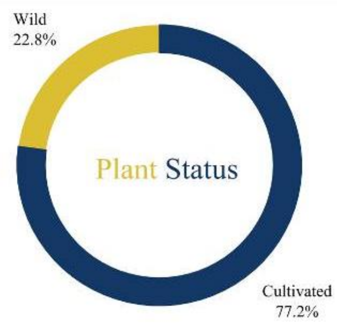

Figure 4. The mode of cultivation of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

Parts used

The plant parts represent the main components used in a plant. Fruits (42.5%) were the most frequently used part in Acehnese cuisine by coastal community in East Aceh District, followed by leaves (25.7%), stems (8.8%), seeds (8%), tubers (4.4%), stem cores (2.7%), flowers (1.8%), bark (0.9%), and banana hearts (0.9%) (Figure 5).

The data show that leaves are the most commonly chosen plant part by the community, possibly due to their ease of processing compared to other plant parts (Ismail and Ahmad 2019; Helmina and Hidayah 2021; Nehru et al. 2024). Leaves are among the most important plant organs, performing critical physiological activities such as photosynthesis, respiration, transpiration, photoreception, and the synthesis and provision of signaling compounds, including growth regulators (Krishnamurthy et al. 2015). Leaves are frequently used because of easy to obtain, simple to process, and contain bioactive compounds with medicinal properties. In culinary use, leaves are highly favored due to their versatility, being used as both main ingredients and complementary items. Leaves are commonly prepared in traditional dishes, including boiled vegetables, stir-fries, and fresh salads. Besides enhancing the flavor, many edible leaves, such as papaya and spinach leaves, are rich in nutrients. Their use in cooking not only adds a distinctive taste but also enriches the nutritional value of the community's daily meals. In terms of their use as spices, stems and rhizomes are prioritized due to the unique aroma and flavor (Saudah et al. 2022). Coastal communities exhibit a rich cultural heritage, as demonstrated by their extensive use of plants for food, including leaves, flowers, fruits, and more. One example is the papaya plant, commonly used by locals to treat malaria and fever, which are frequent ailments for those exposed to the sun daily (Nomleni et al. 2021). The way medicinal plants are utilized and processed in each region is distinct, shaped by local knowledge, experience, and culture. Local ethnobotanical understanding is heavily influenced by environmental conditions and the availability of plant resources (Beltrán-Rodríguez et al. 2014).

The importance of vegetables and spices

The Use Value (UV) of plants used in various traditional Acehnese dishes by coastal community in East Aceh District was calculated to measure the importance of specific plants based on the extent of their benefits. Based on the results, UV ranged from 0.52 to 0.98. Ten plants with the highest UV values were *Cocos nucifera* (0.98), followed by *Nypa fruticans* (0.96), *Citrullus lanatus* (0.96), *Averrhoa bilimbi* (0.95), *Cymbopogon citratus* (0.95), *Allium cepa* (0.94), *Dendrocalamus asper* (0.91), *Luffa acutangula* (0.84), *Solanum melongena* (0.84), and *Cucurbita moschata* (0.83) (Figure 6, Table 2).

These values serve as indicators that plants are highly important and frequently used by the community in the context of vegetables and spices. The RFC of vegetables and spices was calculated to measure the popularity of certain plants based on response frequency provided by respondents. The more individuals who cited a plant, the more popular and frequently used it is, indicating a high level of community knowledge, with RFC values ranging from 0.19 to 0.98. The 10 plants with the highest RFC values were *C. nucifera* (0.98), followed by *Oryza sativa* (0.97), *N. fruticans* (0.96), *Areca catechu* (0.95), *A. cepa* (0.94), *Moringa foetida* (0.93), *Carica papaya* (0.91), *D. asper* (0.90), *Annona muricata* (0.89), and *Pandanus amaryllifolius* (0.88) (Figure 6). These values show the level of agreement among respondents regarding the usefulness of plants in traditional foods, with higher values indicating greater benefits and wide recognition by the community.

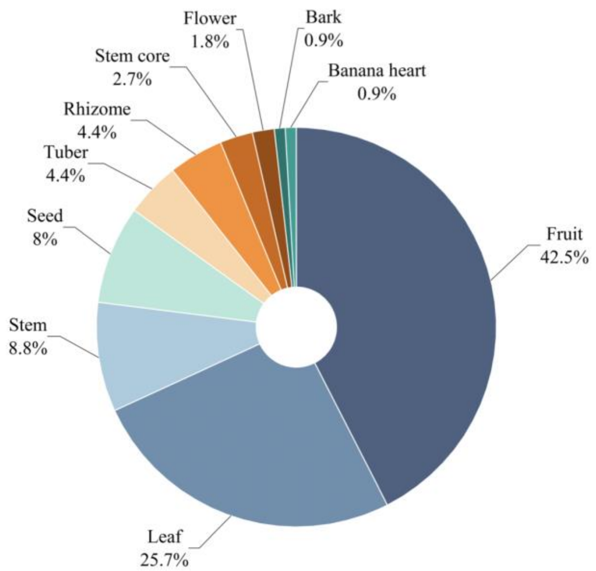

Figure 5. Part of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

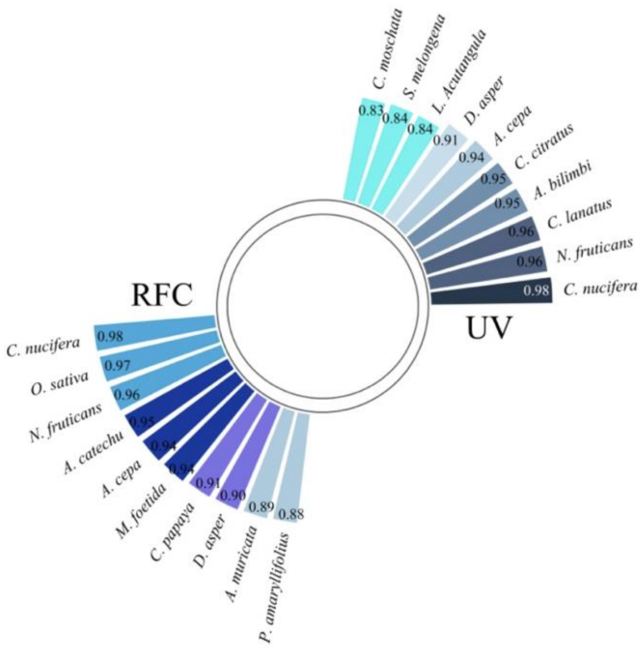

Figure 6. Use Value (UV) and Relative Frequency of Citation (RFC) of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

ICS was calculated to indicate the importance of each plant species to the community, considering aspects such as quality, intensity, and the uniqueness of use. Based on the results, the value of ICS ranged from 1.2 to 144.4. Ten plants with the highest ICS values were *C. nucifera* (144.5), followed by *Allium sativum* (132.7), *M. foetida* (127.7), *Benincasa hispida* (98.4), *Gnetum gnemon* (98.4), *Alpinia galanga* (98.4), *Piper betle* (79.8), *Alocasia brisbanensis* (74.4), *Schizostachyum brachycladum* (73.8), and *Piper nigrum* (73.6), as shown in Figure 7 and Table 2.

Generally, ICS is considered highly important due to the role in maintaining the relationship between humans and the environment, as well as supporting conservation, cultural, and ecological sustainability efforts. It helps identify plants with high cultural value within local communities, particularly in relation to their use in food, medicine, and traditions. The ICS also supports conservation efforts by prioritizing plants that play a significant economic and social role, while simultaneously preserving biodiversity. Furthermore, ICS can serve as a tool to promote the socio-economic sustainability of communities and document traditional knowledge before being lost to modernization. Measuring cultural importance is key to understanding the significance of each plant species to the community, considering aspects of quality, intensity, and uniqueness of its usage (Eni et al. 2019).

CFSI is important to measure the role and value of food plants in the cultural context of a society. By assessing how frequently and significantly certain plants are used as food, CFSI can identify key plants that hold high value from both nutritional and cultural perspectives. It also plays an essential role in biodiversity conservation and protecting traditional knowledge related to local food. Moreover, the CFSI supports food security and helps understand the connections between plant use, health, and cultural identity in the local community. Based on the results, the value of CFSI obtained ranged from 0.54 to 9.96. The 10 plants with the highest CFSI values were *Cocos nucifera* (9.96), followed by *Cuminum cyminum* (2.53), *Gnetum gnemon* (2.53), *Illicium verum* (2.53), *Schizostachyum brachycladum* (1.72), *Diplazium esculentum* (1.44), *Piper betle* (1.21), *Sicyos edulis* (1.1), *Benincasa hispida* (1.03), and *Piper nigrum* (0.99), as shown in Figure 8.

Multiple benefits of vegetables and spices

A wide variety of uses of vegetables and spices were identified across different categories in daily life of coastal community in East Aceh District. The most dominant benefits of plants were for food (100%), followed by economic purposes (68.3%), medicine (67.3%), cultural practices (58.7%), agricultural tools (17.3%), beverages (16.3%), building materials (8.7%), livestock feed (4.8%), handicrafts (3.8%), and dyes (1%). This showed the significant role of plants in various sectors of life, underscoring their multifaceted importance to the community, as presented in Figures 9 and 10.

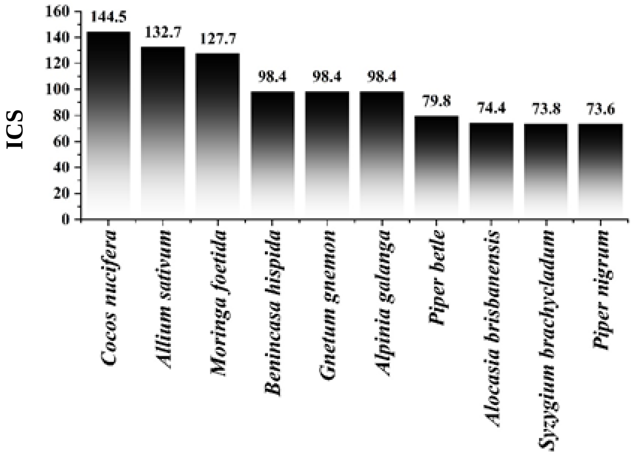

Figure 7. Index of Cultural Significance (ICS) of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

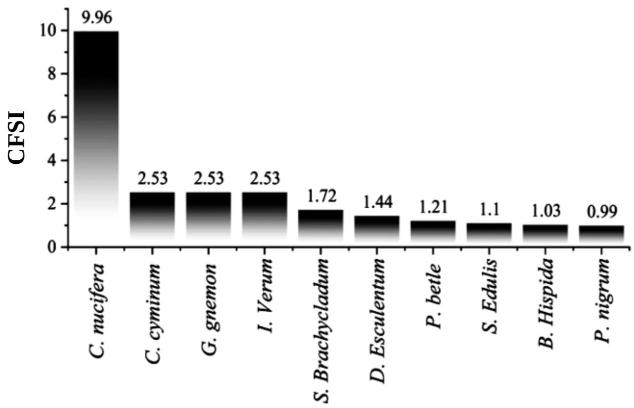

Figure 8. Cultural Food Significance Index (CFSI) of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

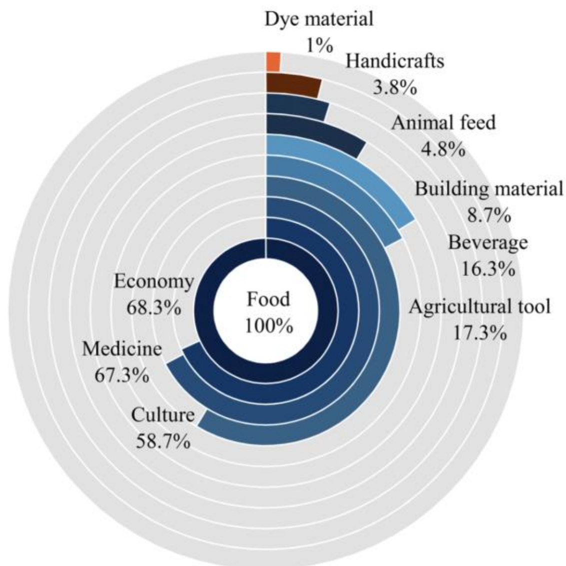

Figure 9. Benefits of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

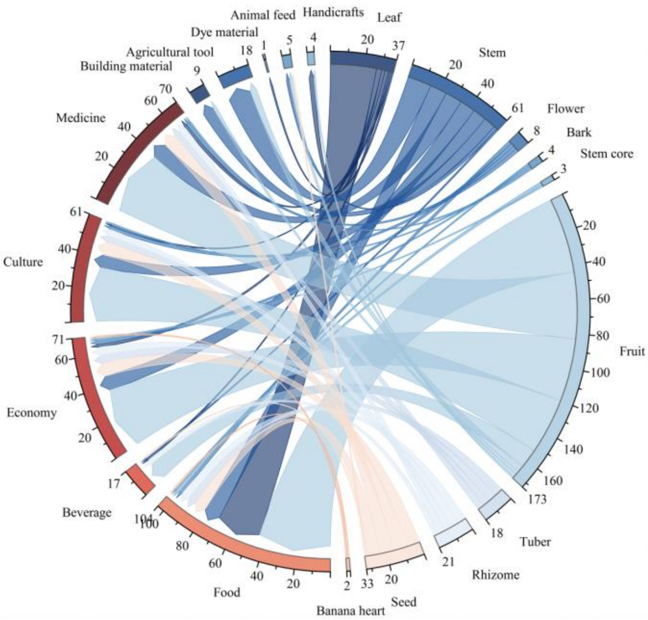

Figure 10. Cross-sectional benefits of vegetables and spices used by coastal community in East Aceh District, Aceh, Indonesia

The role of vegetables and spices for food security in coastal community

Vegetables and spices play a significant role in the food security of coastal community, serving as sources of nutrition, integral parts of culinary traditions, and traditional health practices. Several vegetables, such as water spinach (*Ipomea aquatica)*, spinach (*Amaranthus*), and papaya (*C. papaya*), along with spices including turmeric (*Curcuma longa*) and ginger (*Zingiber officinale*), are commonly used in daily cooking. These plants help maintain dietary diversity and promote health through natural nutrients as well as traditional medicinal benefits. The knowledge and values passed down from ancestors through generations have become a form of local wisdom, providing community with an essential source of guidance for future development (Paulangan et al. 2021). Indonesia's cultural diversity shows the richness of local wisdom, which is in unique traditional foods found in different regions (Fauzi et al. 2020). Local wisdom is an inseparable part of community's culture, influenced by the customs and traditions (Oktaviani et al. 2016; Halim et al. 2017; Nawastuti 2018; Hadie et al. 2021; Purwoko et al. 2021; Prianto et al. 2023). Sustainability in food security can also be preserved through traditional storage and processing method, which extend the shelf life of vegetables and spices, ensuring a stable food supply during lean seasons or extreme weather conditions. Additionally, the community's tradition of sharing harvests strengthens collective food security, ensuring that all members have sufficient access to food resources. This shows that the role of vegetables and spices ensures the nutritional well-being of coastal community supports ecological balance, preserves social traditions, and fosters long-term food independence in a sustainable manner (Yuliana et al. 2021).

The role of coastal vegetables and spices in addressing global food challenges

Coastal vegetables and spices play a significant role in addressing global food challenges, particularly through the ability to adapt to extreme environments. Climate change is one of the most significant challenges globally (Tchonkouang et al. 2024). Plants, livestock, and fisheries all contribute significantly to the global economy and the well-being of populations, but production and supply are highly sensitive to climate change (Godde et al. 2021). When external factors and disruptions such as climate change affect the components of the food system, including food supply, access, and consumption, food security becomes threatened (Gomez-Zavaglia et al. 2020). Climate change is among the world's greatest challenges, impacting the environment, societies, and commercial activities (Ghadge et al. 2020). Previous research suggested that climate change would affect multiple elements related to the food chain, such as agricultural yields, incomes, prices, food access, quality, and food security (Tchonkouang et al. 2024). A reduction of approximately 50% in rainfed agricultural yields was predicted across Africa, with average temperatures rising between 1-3^{o}C (Gomez-Zavaglia et al. 2020). Climate change would increasingly complicate the achievement of food security due to the anticipated negative impacts on agriculture. This phenomenon is expected in developing, tropical, and subtropical countries, where agricultural yields are anticipated to drop significantly, affecting food prices and the economy (Armah et al. 2011). The use of coastal plants such as *Ipomoea aquatica* (water spinach), coconut shoots, and papaya leaves, which are rich in essential nutrients offer a sustainable food solution. These nutrients such as vitamins, minerals, and fiber are obtained from various spices, namely turmeric, ginger, and lemongrass, with health benefits, including anti-inflammatory and antioxidant properties. In addition to their nutritional value, coastal plants also provide solutions for sustainable agriculture. The ability of plants to grow in challenging soil conditions with minimal water shows the potential to adapt to climate change and land degradation. The cultivation of coastal plants minimizes the need for chemical fertilizers and pesticides, thereby supporting environmental conservation. Traditional methods for processing and preserving spices, such as drying and fermentation, help extend shelf life and retain nutritional value. This is particularly beneficial during food crises and logistical challenges. Furthermore, coastal plants contribute to strengthening food security through the practice of sharing harvests. Based on these multiple benefits, coastal vegetables and spices offer innovative solutions for global food security (Allison et al. 2009).

Recommendations for innovation for sustainable management and development

Innovations for sustainable management are essential for addressing environmental challenges. A technology-driven method advocates for greater use of biotechnology as the best strategy to meet food demands while achieving conservation benefits from further agricultural development (Meemken and Qaim 2018). In developed countries, analysis often focuses on the prevalence of industrial farming systems, which can cause significant environmental harm despite increases in production yields (Robinson 2018). However, the impacts of climate change are shown globally, affecting agricultural productivity (Guo et al. 2020; Ortiz-Bobea et al. 2021). There is growing recognition of the need to adapt to and mitigate climate change when more sustainable farming systems are to be implemented. These systems are based on the principles, functions, and processes of agroecology in agricultural systems. Agroecology has become a comprehensive term for the application of specific agricultural methods that focus on production and ecosystem preservation (Krebs and Bach 2018). It generally includes specific ecological principles, such as polyculture, plant rotation, agroforestry, cover crops, and the integration of crop and livestock production (Altieri and Nicholls 2005). However, achieving sustainability requires adopting certain land management methods and optimizing resource use. This is essential to reduce dependence on non-renewable resources within the farming ecosystem, preserve biodiversity, match cropping patterns to environmental constraints, and maximize the use of local knowledge and practices (Raymond et al. 2016; Smith et al. 2020). The methods also offer a holistic solution to achieving long-term sustainability in agriculture, ensuring that ecosystems are preserved to meet global food needs.

Vegetables and spices make a substantial contribution to coastal communities' food security, providing inherent nutritional content. Traditional processing processes such as fermentation also assist in increasing food shelf life, ensuring that stockpiles are available in harsh conditions. The practice of sharing harvests throughout the community improves collective food security and allows community members to access food. Plants such as coconut tuber and turmeric thrive on nutrient and water-poor soils, promoting sustainable agriculture. Furthermore, traditional procedures such as drying and fermenting assist to preserve nutritional content and reduce food losses in the worldwide distribution chain.

Agroecology-based innovations, including crop rotation and agroforestry, are essential methods for developing sustainable agricultural systems. Local resource optimization and the use of biotechnology are also required to fulfill global food demands while protecting the environment. This strategy allows for sustainability without damaging ecosystems, hence helping future food security. The conversation underlined the importance of plants in many facets of life, including nourishment and environmental sustainability, particularly during climate change issues. Therefore, conservation organizations and local governments should emphasize the preservation of traditional food sources by promoting sustainable use practices and conservation strategies such as community gardens.

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