What shapes traditional food plant use? Correlates of consumption and associations with perceived well-being in three socio-ecological settings of Indonesia

Yen Yen Sally Rahayu, Adi Bejo Suwardi, Anisa Anggraeni, Arifin Surya Dwipa Irsyam, Raissa Manika Purwaningtias, Wawan Sujarwo

Correspondence

Yen Yen Sally Rahayu[1*], Adi Bejo Suwardi[2], Anisa Anggraeni[3,4], Arifin Surya Dwipa Irsyam[5], Raissa Manika Purwaningtias[6], Wawan Sujarwo[1]

[1]Research Center for Ecology, National Research and Innovation Agency (BRIN), Cibinong 16911, Indonesia.
[2]Department of Biology Education, Universitas Samudra. Jl. Prof. Dr. Syarief Thayeb, Langsa 24416, Indonesia.
[3]Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650201, China.
[4]University of Chinese Academy of Science, Yanqihu East Rd., Huairou District, Beijing 101408, China.
[5]School of Life Sciences and Technology, Institut Teknologi Bandung, Jl. Ganesha 10, Bandung 40132, Indonesia.
[6] Indonesia NIHR Global Health Research Center, Brawijaya University, Veteran Street, Malang 65145, Indonesia.

*Corresponding Author: yenyenrahayu@gmail.com; yen.yen.sally.rahayu@brin.go.id

Ethnobotany Research and Applications 32:44 (2025) - http://dx.doi.org/10.32859/era.32.44.1-25
Manuscript received: 03/11/2025 - Revised manuscript received: 23/11/2025 - Published: 24/11/2024

Research

Abstract

Background: Traditional food plants (TFPs) are integral to dietary resilience in Indonesia, yet their consumption dynamics and potential health links remain understudied. This study aims to document TFPs' use, examine factors correlated with consumption, and explore their associations with perceived health and well-being.

Methods: A cross-sectional survey of 335 participants in three socio-ecologically distinct provinces (West Java, West Nusa Tenggara, Aceh) employed food frequency questionnaires and a standardized self-rated health and well-being survey. Bivariate correlation and multiple regression analyses were applied to analyze the associations.

Results: We documented 121 TFP species from 49 families. Frequent consumption was most common in West Nusa Tenggara (61%), followed by Aceh (42%) and West Java (15%), with most TFPs sourced from unmanaged landscapes. Agricultural and dietary factors were the most consistent correlates of TFP consumption across sites. Associations with well-being varied by location. In West Java, TFP intake was associated with a mental well-being component (Social Functioning). In West Nusa Tenggara, it was associated with a mental component (Mental Health) and a physical component (General Health). In Aceh, an initial association with a physical component (General Health) was not significant after adjusting for confounders.

Conclusions: The relevance of TFPs persists across Indonesia's diverse socio-ecological settings. As consumption patterns and perceived benefits of well-being are context-specific, promotion efforts could be locally tailored and coupled with efforts to protect access to natural habitats.

Keywords: Traditional food plants, Well-being, Consumption pattern, Indonesia, Ethnobotany

Background

Traditional food plants (TFPs), including wild, semi-wild, and locally adapted cultivated species, are integral to food systems worldwide, especially in rural and Indigenous communities (Bharucha & Pretty 2010, Hunter *et al.* 2019). They are linked to greater dietary diversity, improved micronutrient intake, and dietary resilience during environmental or economic stress (Boedecker *et al.* 2014, Roche *et al.* 2008). Amid global dietary simplification and the dominance of a narrow set of staple crops, interest has grown in leveraging traditional and locally rooted foods to strengthen food security and nutrition, with TFPs central to this effort (Hunter *et al.* 2019, Kuhnlein 2014). Many traditional varieties are nutrient-dense and can help address micronutrient deficiencies, particularly in remote or resource-constrained areas (Flyman & Afolayan 2006, Powell *et al.* 2015, Rahayu *et al.* 2024). Their nutrient profiles—rich in minerals, fiber, vitamins, and fatty acids—make them useful complements to staple foods (Ahmad & Pieroni 2016, Hunter *et al.* 2019, Padulosi *et al.* 2013). Studies from Asia show that indigenous vegetables can supplement the daily diet and sometimes substitute for commonly consumed vegetables (Ogle *et al.* 2001b, Punchay *et al.* 2020). Several TFPs also have documented biological and pharmacological effects with potential health benefits (Punchay *et al.* 2020, Rahayu *et al.* 2020, 2022, Smith *et al.* 2019).

In Indonesia, a global biodiversity hotspot with immense cultural diversity, a wide array of edible plant species is embedded in local knowledge systems and culinary traditions (CBD 2025, Pawera *et al.* 2020, Rahayu *et al.* 2024, Sujarwo *et al.* 2025). In this diverse landscape, Indonesians are reported to consume at least 900 edible plant species (Walujo 2011). Indonesian studies consistently demonstrate that TFPs play a crucial role in supporting rural diets across various settings. Examples include ethnobotanical surveys documenting local food plants in the Rancakalong Subdistrict in West Java (Rahayu et al. 2024), the Hulu Subdistrict in West Kalimantan (Purwayantie & Suryadi 2020), Bali (Sujarwo *et al.* 2015), and the slopes of Merapi and Merbabu (Umartani 2021). Market evidence aligns with these findings, as shown by a survey of traditional markets in East Jakarta, which recorded a wide range of edible plants (Afrianto *et al.* 2024). Studies of wild edible fruits in East Aceh and Bengkulu note uses that extend beyond food (Suwardi *et al.* 2022,2023). While across the Mentawai Islands and West Sumatra, research records indigenous knowledge of wild food plants alongside evidence of conservation value and favorable local views (Lee *et al.* 2021, Pawera *et al.* 2020).

Despite their documented significance, the contemporary dynamics of TFP use in Indonesia remain largely unexplored. Beyond TFP inventory and nutritional profiling, the factors influencing their consumption remain poorly understood. Existing work suggests that use of non-timber forest products, including TFPs, reflects a complex interplay of broad factors, such as socio-demographic (e.g., age, gender, education), economic (e.g., income, market access), and livelihood characteristics (e.g., reliance on agriculture, access to land) (Cooper *et al.* 2018, Hickey *et al.* 2016, Termote *et al.* 2012, Timko *et al.* 2010). Furthermore, dietary patterns and cultural food preferences are known to influence consumption choices significantly (Kuhnlein & Receveur 1996, Monterrosa *et al.* 2020, Rahayu *et al.* 2024). However, the factors that matter most are debated and vary across socio-ecological contexts. For instance, socio-economic status does not uniformly predict TFP use: although often characterized as 'foods of the poor,' some settings show greater harvesting or purchasing by wealthier households due to better access to land, labor, tools, and markets (Angelsen *et al.* 2014, Mcelwee 2008). Similarly, the influence of market integration is mixed: in rural Tanzania, greater access coincided with a decline in wild-food use, whereas in parts of West Africa it created new commercial opportunities (Leite *et al.* 2024, Olesen *et al.* 2024). These context-dependent patterns highlight the need for comparative work to distinguish between general and place-specific influences on consumption.

Another gap concerns the evidence linking TFP consumption to health outcomes. While the nutritional value of many TFPs is established, empirical research connecting their regular intake to tangible health benefits remains limited (Kennedy *et al.* 2021, Raneri *et al.* 2023). This gap is compounded by a narrow focus on physical health, overlooking the broader, multidimensional nature of health and well-being, including both physical and mental components that TFPs may support. The relationship between TFPs and well-being is not universal but is shaped by local context. For example, in Tanzania, the consumption of wild food correlated with self-reported general health in a semiarid region, while in a coastal area, it was also associated with mental health, influencing emotion and vitality. This disparity is likely tied to differences in wild food diversity and local context (Sakamoto *et al.* 2023b). Such context-specificity highlights a dimension that often falls outside the scope of large-scale public health dietary studies (Kennedy *et al.* 2021, Raneri *et al.* 2023). Therefore, more research is needed that combines ethnobotany and public health to explore how TFP intake relates to different aspects of well-being within specific socio-ecological contexts (Govindaraju *et al.* 2018, Sakamoto *et al.* 2023b, Vajdi & Farhangi 2020).

These research gaps are particularly relevant in Indonesia, given its diverse culture and socio-ecological zones. This study aims to address these gaps by examining the dynamic use of TFP across contrasting contexts in three Indonesian provinces: the increasingly urbanized Sundanese region of West Java, the forest-proximate communities of Aceh, and the dryland area

of West Nusa Tenggara (BMKG 2025, Rahayu *et al.* 2024, Suwardi *et al.* 2020a). The research is guided by three specific objectives: (1) to document the diversity of TFPs incorporated into local diets; (2) to analyze TFP use patterns, including consumption frequency and acquisition methods, and identify the key factors correlated with their consumption across different contexts; and (3) to examine the site-specific associations between TFP intake and perceived well-being while controlling for potential confounders.

Materials and Methods

Study area

The data presented was obtained from surveys in rural areas of three Indonesian provinces representing distinct socio-ecological settings: Aceh Province (northern Sumatra), West Java Province (western Java), and West Nusa Tenggara (WNT) Province (eastern Lesser Sunda Islands) (Fig. 1). Aceh represents a forest-adjacent area with strong foraging practice (Suwardi *et al.* 2020a), West Java represents a densely populated, increasingly urbanized area (Rahayu *et al.* 2024), and WNT represents a dryland agricultural area (Ani *et al.* 2021, BMKG 2025). We conducted a cross-sectional survey between August 2023 and July 2025, focusing on three regencies selected for their accessibility and the availability of local informants.

In West Java Province, the research took place in the rural highlands of Bandung Barat Regency, focusing on Rongga Subdistrict (approx. 6°59′ S, 107°16′ E; 900-1,000 m a.s.l.) (BPS 2024a). This site was chosen as a case study of the rapid changes in West Java, Indonesia's most populous and economically developed province (BPS 2024b). The landscape features rice fields (sawah), mixed gardens (**kebun**), horticultural and tea plots, and home gardens (**pekarangan**) on fertile volcanic soils. The area has a cool, humid tropical climate (mean temperature ≈ 20-22 °C; annual rainfall ≈ 2,500 mm). The study was conducted among Sundanese communities whose livelihoods are increasingly diverse. While smallholder farming of vegetables and commercial crops, such as tea, continues, many residents now commute daily or work seasonally in the manufacturing and service sectors of nearby urban centers. Leafy vegetables are central to Sundanese food culture (Hernawati *et al.* 2022). The Sundanese are known for their traditional practice of eating fresh or lightly prepared greens, called **lalapan** (**lalap**/**lalab**), which often include a diversity of traditional leafy plants. Today, **lalapan** is sourced from both household production and local markets, as it has become a staple of Indonesian gastronomy (Rahayu *et al.* 2024). This setting illustrates how traditional ecological knowledge and Sundanese culinary practice are maintained while being shaped by urban market linkages.

Fieldwork in Aceh Province focused on the Tamiang Hulu Subdistrict, including Kaloy and nearby villages on the edge of the Leuser Ecosystem (approx. 4°3′ N, 97°49′ E; 60-120 m a.s.l.). This area was chosen to reflect the lives of people residing close to the forest in one of Sumatra's key conservation zones (BPS 2024c). The climate is humid tropical, with average temperatures around 26-27 °C and about 2,800 mm of annual rainfall. The land is covered with lush vegetation on rolling soil. Villages are dispersed along rivers and around agroforests, with population density significantly lower than in the lowlands. Land use combines agroforestry gardens, secondary forests, and home gardens. Most residents are smallholder farmers cultivating rubber, oil palm, and food crops, while continuing to gather wild edible plants from adjacent forest patches and riparian zones (Suwardi *et al.* 2020a).

In WNT Province, research was conducted in the subdistricts of Donggo, Lambitu, and Wawo within Bima Regency (approx. 8°8′ S, 117°46′ E; 319-714 m a.s.l.) (BPS 2024d). This site was selected to represent the distinctive dryland agroecosystems of the eastern Indonesian islands. The area has a semi-arid climate, with annual rainfall generally below 2000 mm and a prolonged dry season that often leads to water shortages (Krisnawan *et al.* 2025, Suriadi *et al.* 2021). Steep slopes and heterogeneous geology produce predominantly shallow, stony soils with low fertility. These conditions support dryland farming systems in which drought-resistant crops such as sorghum and cassava are essential to local diets (Fitrahtunnisa *et al.* 2020, Murdhani *et al.* 2025). Indonesian culinary research notes grilling, boiling/simmering, and steaming as longstanding methods in the area (Wijaya 2019). This suggests that WNT foodways are closer to eastern Indonesian patterns, which emphasize non-rice staples and lighter seasoning, rather than to the rice-based, heavily spiced cuisines typical of the western islands.

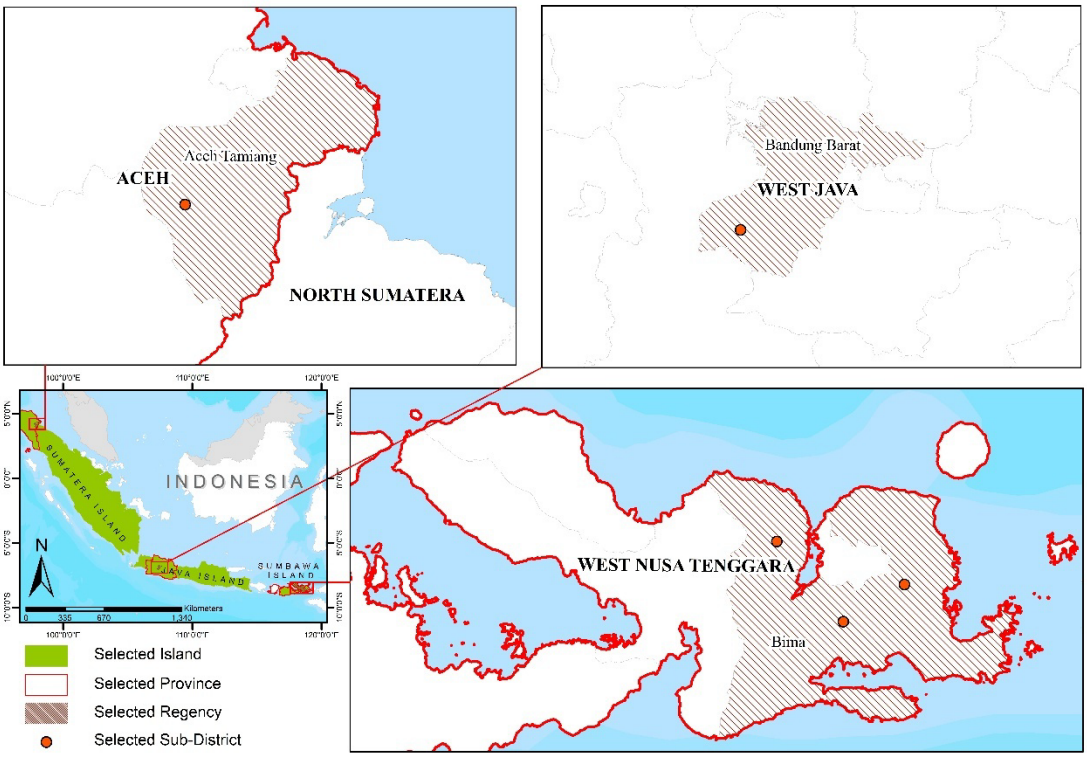

Figure 1. Studied locations in three provinces in Indonesia: West Java, Aceh, and West Nusa Tenggara.

Data Collection

The survey employed a five-module questionnaire, including open-ended sections for ethnobotanical listing and sourcing practices, as well as modules for consumption frequency (FFQ), socio-demographic and livelihood variables, and standardized well-being/HRQoL status (SF-12). Prior to survey administration, informed consent was obtained from all participants in writing after explaining the research objectives, procedures, potential risks, and benefits. The study was conducted in compliance with the Code of Ethics of the International Society of Ethnobiology (ISE 2008) and received ethical approval from the Ministry of Health, Bandung Health Polytechnic, Indonesia (No. 05/KEPK/EC/V/2023).

A total of 335 participants were recruited across three provinces: 113 from West Java, 107 from WNT, and 115 from Aceh. Participants were selected through stratified random sampling to ensure representation across different age groups, genders, and socioeconomic statuses within each province (Table 1). The inclusion criteria required participants to be adults aged 18 or older and to be residents of the study communities for at least 12 months.

The Food Frequency Questionnaires (FFQs) were employed to gather information on participants' food plant consumption, including both TFP and conventional vegetables/fruits (non-TFP). This included free-listing of commonly consumed TFPs (see TFP listing method below) and their consumption frequency, which was classified into three levels: 4-7 times a week, 2-3 times a week, or once a week or less (Sakamoto *et al.* 2023b). This ex-situ approach was deliberately chosen to document plants that were actually consumed rather than merely available in the environment. While this approach typically yields a smaller species list than *in-situ* surveys, it provides data on the plants that actually constitute the local diet (Gallois *et al.* 2021).

To document TFPs consumed by participants in the previous month, we conducted open-ended interviews using a standard free-listing approach (Silva *et al.* 2014). Before listing, enumerators introduced the study's definition of TFPs as edible species or landraces with a documented and locally recognized history of use and cultural significance in the study communities, embedded in everyday or ritual foodways, and primarily sourced from surrounding agroecosystems (home gardens, mixed fields, agroforestry plots, wild and semi-domesticated stands). This definition does not require plants to be "unconventional" or rare; instead, it emphasizes their locally rooted and culturally meaningful roles. This operationalization aligns with the literature on traditional/Indigenous food systems and wild/indigenous vegetables, which emphasizes place-based foods from

local environments that are culturally accepted and acquired through foraging, small-scale cultivation, or mixed management (Kennedy *et al.* 2021, Kuhnlein & Chotiboriboon 2022, Luo *et al.* 2024). For each listed item, participants provided local names and edible parts. In contrast, throughout the text, vegetables/fruits (used interchangeably with 'produce,' 'conventional vegetables/fruits,' and 'common vegetables/fruits') refer to cultivated or market-standard vegetables and fruits (e.g., tomato, carrots, and cabbage) and are distinct from TFPs.

Plant specimens were collected and subsequently identified at Universitas Samudra, Aceh, and the Herbarium Bandungense (FIPIA), West Java. The plants were identified by comparing their characteristics with those listed in the literature obtained from standard sources, such as the Flora Malesiana, Flora of China, and Flora of Java. Scientific nomenclature was updated in accordance with the Plants of the World Online (POWO 2025).

Acquisition information was gathered separately, at the participant level rather than per plant. Participants could report all applicable ways they obtain TFPs (e.g., from wild areas, self-cultivated, or purchased). According to the TFP definition in this study, 'wild areas' are broadly defined to include not only natural forests but also managed landscapes such as mixed gardens and rice-field ridges, where plants grow spontaneously with minimal or no human care (Rahayu *et al.* 2024).

To gather information on potential factors influencing TFP consumption, we examined a set of socio-demographic, economic, health, and livelihood variables. Prior studies show that factors such as age, family size, education, occupation, body mass index (BMI), and chronic illness can shape dietary choices (Sakamoto *et al.* 2023b). Economic conditions, including household expenditure and food assistance, also affect access to traditional foods (Erber *et al.* 2010). Agricultural practices, such as home gardening, livestock rearing, and access to agricultural land, influence the local availability of TFPs (Hetherington *et al.* 2017, Wegenast *et al.* 2025)**.** Accordingly, we included the following variables in our analysis: age, gender, education level, occupation, household size, monthly income, source of income (whether a farmer or not), BMI, chronic illness, consumption of vegetables and fruits, home gardening, livestock rearing, and access to agricultural land. This set of information was collected using semi-structured questionnaires.

Well-being assessed in this study is self-rated; therefore, the measure reflects perceived (subjective) well-being. In this study, we use the terms 'well-being' and 'health and well-being' interchangeably throughout the manuscript to maintain readability while referring to the same concept. We used health-related quality of life (HRQoL) as a proxy for well-being (Sakamoto *et al.* 2023b). HRQoL is increasingly recognized as a crucial indicator of overall health and well-being, complementing objective medical evaluations (Guyatt *et al.* 1993). To measure HRQoL, we employed the Short Form-12 (SF-12) questionnaire, a condensed version of SF-36 (Ware *et al.* 1995). This instrument is a standard tool for self-reported HRQoL (Zereyesus *et al.* 2016) and has been validated in the Indonesian context (Wicaksana *et al.* 2020).

The Short Form-12 has also been instrumental in exploring connections between dietary patterns and HRQoL (Sakamoto *et al.* 2023b). The SF-12 questionnaire comprises two components:

1) Physical Component Summary (PCS): Derived from scores related to Physical Functioning, Role Physical, Body Pain, and General Health.
2) Mental Component Summary (MCS): Derived from scores related to Vitality, Social Functioning, Role Emotional, and Mental Health.

For a detailed description of HRQoL indicators, refer to Supplementary Table 1.

Table 1. Participant characteristics (n=335).

Variable	Descriptive measurements			
	Mean [SD] or percent			
	West Java (N=113)	Aceh (N=115)	West Nusa Tenggara (N=107)	Total (N=335)
Gender				
Man	43%	43%	34%	40%
Woman	57%	57%	66%	60%
Age	45 [14]	39 [12]	45 [20]	43 [16]

BMI	22 [3]	22 [6]	23 [3]	22 [4]
Having a chronic illness				
No	95%	91%	92%	93%
Yes	5%	9%	8%	7%
Family size	3[1]	5 [1]	4 [1]	4 [1]
Education level				
None	3%	16%	0	7%
Primary school	71%	31%	13%	39%
Middle school	19%	34%	5%	19%
High school	4%	16%	70%	29%
Higher than HS	3%	3%	12%	6%
Source of income				
Non-farmer	25%	66%	48%	46%
Farmer	75%	34%	52%	54%
Household expenditure (in k IDR)	1929 [902]	840 [553]	585 [235]	1126 [857]
Vegetables /fruits consumption				
Low	27%	8%	38%	24%
Moderate	22%	44%	5%	24%
High	51%	48%	57%	52%
Home gardening				
No	36%	77%	67%	60%
Yes	64%	23%	33%	40%
Livestock rearing				
No	62%	89%	78%	76%
Yes	38%	11%	22%	24%
Agricultural land access				
No	21%	68%	47%	45%
Yes	79%	32%	53%	55%

Data Analysis

Data were analyzed using SPSS Statistics version 25. Descriptive statistics summarized TFP diversity, consumption patterns, and acquisition methods.

The consumption frequency was interpreted as follows: '4 to daily a week' as high or frequent, '2-3 times' a week as moderate, and 'once a week or less' as low. Chi-square tests examined geographic differences in the frequency of TFP consumption.

Acquisition methods were analyzed by grouping reported sources into five initial categories: (1) harvested from wild areas, (2) self-cultivated in home gardens, (3) purchased, (4) received as gifts, or (5) combinations of these. Since the 'gift' category never appeared on its own, and one source was overwhelmingly more common than the others, we simplified into a three-level categorization: (1) harvested from wild areas, (2) self-cultivated in home gardens, and (3) purchased.

To examine bivariate correlates of TFP consumption, we used non-parametric tests. Spearman's rank correlation was applied when the correlate was continuous or ordinal (e.g., age, education level, household size, income), and Chi-square tests (χ^2) were used for dichotomous variables (e.g., gender, occupation, access to livestock and agricultural land). We also assessed bivariate associations between TFP consumption and each HRQoL domain using Spearman's rank correlation. For HRQoL domains that showed significant correlations with TFP consumption, we then performed multivariate linear regression to determine whether the association persisted after controlling for potential confounders, including age, BMI, education level,

chronic illness, dietary patterns, and livelihood characteristics. The variance inflation factor (VIF) for all variables was below 10, indicating no significant multicollinearity. All analyses used two-tailed tests with a significance level of $p < 0.05$.

Results

Diversity of TFPs

Across the three study areas, the survey documented 36 TFP species in Aceh, 58 in West Java, and 60 in WNT that were part of local diets. After accounting for overlap among the areas, a total of 121 TFPs from 49 families were listed (Supplementary Table 2), with the top 50 most commonly consumed listed in Table 2. The most diverse plant families were Cucurbitaceae and Fabaceae, each contributing 12 species. These are followed by Moraceae and Solanaceae (each with eight species), Asteraceae (six species), and Myrtaceae (five species). Amaranthaceae, Arecaceae, and Zingiberaceae each included four species, while all other families contributed three or fewer species. Fruits and leaves were the most frequently consumed parts (43% and 31%, respectively), followed by other parts consumed in smaller proportions (each ranging between 1-5%), such as flowers, aerial parts, rhizomes, shoots, whole plants, fruiting bodies, and mixed combinations (e.g., fruits and flowers, leaves and stems, leaves and fruits).

In WNT, participants often mentioned staple tubers such as *Colocasia esculenta* (**talas**), *Ipomoea batatas* (**ubi jalar**), and *Manihot esculenta* (**singkong**), as well as vegetables such as *Moringa oleifera* (**kelor**), *Momordica charantia* (**pare**), and *Amaranthus hybridus* (**bayam**). In West Java, leafy greens were frequently cited, including *Sicyos edulis* (**labu siam,** aerial parts), *Cnidoscolus aconitifolius* (**daun gedang jepang**), *Crassocephalum crepidioides* (**sintrong**), and *Pilea melastomoides* (**pohpohan**). In Aceh, forest fruits such as *Artocarpus integer* (**cempedak**), *Musa acuminata* (**pisang hutan**), and *Durio zibethinus* (**durian**) were commonly reported, alongside vegetables such as *Stenochlaena palustris* (**pakis**), *Solanum torvum* (**tekokak**), *Etlingera elatior* (**kecombrang**), and *Coccinia grandis* (**timun hutan**). Eight species were consistently reported in all three areas, forming a common set of vegetables and spices: *M. charantia*, *S. edulis*, *M. esculenta*, *Vigna unguiculata*, *Cocos nucifera*, *Capsicum annuum*, *Curcuma longa*, and *Zingiber officinale*.

TFP use patterns

Consumption frequency was categorized as high (4 times or more in a week), moderate (2-3 times a week), and low (weekly or less) (see Methods). As shown in Fig. 2, we found differences in TFP consumption frequency across the study areas (χ^2 (4, N = 335) = 62.05, p < 0.001). High frequency consumption was common in WNT (61%), followed by Aceh (42%) and West Java (15%). At the moderate level, West Java accounted for the largest proportion (33%), with Aceh contributing 28% and WNT only 4%. For low consumption, West Java contributed the largest share (52%), followed by WNT (35%) and Aceh (30%). Across all sites, when moderate and high consumption are combined, at least half of households in each province consumed TFPs at least moderately (2-3 times per week).

Regarding the acquisition method, about 87% (N = 293) of participants reported at least one way to obtain TFP. Fig. 3 illustrates the acquisition method, excluding the 'none' response (13%, N= 42). In all three provinces, from the wild' was the dominant way to obtain TFPs, reported by 109 participants (~97%) in West Java, 71 participants (~80%) in WNT, and 84 participants (~91%) in Aceh. Cumulatively, ~90% of participants across the three study sites gathered TFP that grew naturally in forests, **kebun** (mixed gardens), and **pematang sawah** (rice-field ridges). A smaller proportion of participants relied on self-cultivation or purchase, which make up ~8% and ~2% of the total participants, respectively. The detailed breakdown of habitats and combinations is provided in Supplementary Materials, Fig. S1.

TFP consumption correlates

Table 3 shows the bivariate associations between TFP consumption and potential correlates. Only significant associations are presented. Across sites, being a farmer (χ^2 = 10.934 in West Java, χ^2 = 8.019 in WNT, and χ^2 = 6.479 in Aceh), livestock rearing (χ^2 = 40.818 in West Java, χ^2 = 16.310 in WNT, and χ^2 = 8.503 in Aceh), and consumption of common vegetables/fruits (ρ = 0.652 in WNT, and ρ = 0.596 in Aceh) were significantly associated with TFP consumption. However, in West Java, higher vegetable/fruit consumption was associated with lower TFP intake (ρ = -0.679). In West Java and Aceh, home gardening (χ^2 = 11.435 in West Java and χ^2 = 33.934 in Aceh) and access to agricultural land (χ^2 = 15.779 in West Java and χ^2 = 8.542 in Aceh) were associated with higher TFP consumption. Expenditure was significantly correlated in WNT (ρ = 0.553) and Aceh (ρ = 0.220). Higher education level was associated with lower TFP consumption in West Java (ρ = -0.235), while higher BMI was associated with higher TFP consumption in Aceh (ρ = 0.625). Overall, agricultural and dietary factors appeared as the most consistent correlates of TFP consumption, while education, BMI, and expenditure showed site-specific effects. No significant associations were observed for gender, age, or chronic illness ($p > 0.05$).

Table 2. The top 50 traditional food plants are most commonly used in the local diet across the three sites.

Family	Scientific name	Local name	Edible part	Location (citation frequency)
Amaranthaceae	*Amaranthus hybridus* L.	Nadu[1], bayam[4]	Leaves	WNT (54)
Amaranthaceae	*Amaranthus spinosus* L.	Bayam duri[3,4], bayam liar[2]	Leaves	Aceh (7), WJ (10)
Apiaceae	*Centella asiatica* (L.) Urb.	Antanan[2], pegagan[4]	Leaves	WJ (46)
Apiaceae	*Eryngium foetidum* L.	Welang[2], walanggeni[4]	Leaves	WJ (71)
Araceae	*Colocasia esculenta* (L.) Schott	Talas merah[3], ntala[1], talas[4]	Whole part	Aceh (10), WNT (90)
Araliaceae	*Hydrocotyle sibthorpioides* Lam.	Antanan beurit[2]	Leaves	WJ (13)
Arecaceae	*Calamus caesius* Blume	Rotan[3,4]	Young shoots	Aceh (33)
Arecaceae	*Cocos nucifera* L.	Kelapa[1,2,3,4]	Fruits	WNT (38), WJ (26), Aceh (27)
Aspleniaceae	*Stenochlaena palustris* (Burm.) Bedd.	Pakis[3,4]	Aerial parts	Aceh (51)
Asteraceae	*Acmella ciliata* (Kunth) Cass.	Jotang[2,4]	Aerial parts	WJ (12)
Asteraceae	*Crassocephalum crepidioides* S. Moore	Sintrong[2,4]	Leaves	WJ (65)
Asteraceae	*Emilia sonchifolia* (L.) DC.	Jonge[2]	Leaves	WJ (22)
Asteraceae	*Sonchus arvensis* L.	Camawak/lampenas[2]	Leaves	WJ (17)
Brassicaceae	*Rorippa indica* (L.) Hiern	Kamanilan[2]	Leaves	WJ (50)
Convolvulaceae	*Ipomoea aquatica* Forssk.	Kangkung merah[3,4], lara[1]	Aerial parts	Aceh (4), WNT (30)
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	Hui[2], ro'o uwi[1], ubi[4]	Leaves	WNT (tubers: 85, leaves: 64), WJ (tubers: 15, leaves: 35)
Cucurbitaceae	*Coccinia grandis* (L.) Voigt	Timun hutan[3,4]	Fruits	Aceh (33)
Cucurbitaceae	*Cucurbita moschata* Duchesne	Ponda[1], labu kuning[4]	Fruits	WNT (7), Aceh (16)
Cucurbitaceae	*Cucurbita pepo* L.	Labu[3]	Fruits	Aceh (7)
Cucurbitaceae	*Momordica charantia* L.	pria[1], paria[2], peria[3], pare[4]	Leaves, fruits	WNT (fruits: 97, leaves:29), WJ (4), Aceh (3)
Cucurbitaceae	*Sicyos edulis* Jacq.	Waluh[2], labu siam[4]	Aerial parts	WNT (34), WJ (113), Aceh (5)
Euphorbiaceae	*Cnidoscolus aconitifolius* (Mill.) I.M. Johnst.	Gedang jepang[2], pepaya jepang[4]	Leaves	WJ (78)
Euphorbiaceae	*Manihot esculenta* Crantz	Sampeu[2], ro'o bojo[1], singkong[4]	Leaves, tubers	WJ (leaves: 93), WNT (tubers:80, leaves:10, Aceh (tubers: 4)
Fabaceae	*Cajanus cajan* (L.) Huth	Hiris[2]	Fruits	WJ (14)
Fabaceae	*Parkia speciosa* Hassk.	Petai[3,4]	Fruits/ seeds	Aceh (26)
Fabaceae	*Psophocarpus tetragonolobus* (L.) DC.	Jaat/kicipir2, kecipir[4]	Fruits	WJ (63)
Fabaceae	*Vigna unguiculata* (L.) Walp.	Bue[1], kacang panjang[4]	Fruits, young leaves	WNT (20), Aceh (15), WJ (10)
Hydrocharitaceae	*Limnocharis flava* (L.) Buchenau	Bang eng[2], genjer[2,3,4]	Aerial parts	WJ (70), Aceh (5)

Malvaceae	*Abelmoschus esculentus* (L.) Moench	Bamea[1], okra[4]	Fruits	WNT (10)
Malvaceae	*Durio zibethinus* L.	Durian[3,4]	Fruits	Aceh (72)
Moraceae	*Artocarpus heterophyllus* Lamk	Nagga dori[3], nangka[4]	Young fruits	WNT (14), Aceh (5)
Moraceae	*Artocarpus integer* (Thunb.) Merr.	Cempedak[3,4]	Fruits	Aceh (57)
Moraceae	*Artocarpus altilis* (Parkinson) Fosberg	Sukun[3,4]	Fruits	Aceh (44)
Moraceae	*Artocarpus altilis* (Parkinson) Fosberg	Kelewih[2*], kluwih[4]	Fruits	WJ (20)
Moraceae	*Ficus virens* Aiton	Bunut[2]	Young leaves	WJ (31)
Moringaceae	*Moringa oleifera* Lam.	Kelor[1,2,4]	Leaves	WNT (109), WJ (3)
Musaceae	*Musa acuminata* Colla	Kahuntu kalo[1], pisang hutan[3,4]	Flowers/ blossoms	WNT (19), Aceh (45)
Phyllanthaceae	*Breynia androgyna* (L.) Chakrab. & N.P. Balakr.	Katuk[2,4], kambesi[1]	Leaves	WJ (6), WNT (23)
Poaceae	*Dendrocalamus asper* (Schult. & Schult. f.) Backer	Kakando3, rebung[4]	Shoot	WNT (6), Aceh (15)
Poaceae	*Saccharum × edule* Hassk.	Turubuk[2]	Flowers bud	WJ (28)
Pontederiaceae	*Pontederia vaginalis* Burm.f.	Eceng[2]	Aerial parts	WJ (66)
Rubiaceae	*Canthium horridum* Blume	Cingcau[2], cincau hutan[4]	Leaves	WJ (37)
Solanaceae	*Capsicum annuum* L.	Cabe[1,2,3,4]	Fruits	WNT (31), WJ (46), Aceh (38)
Solanaceae	*Solanum americanum* Mill.	Leunca[2,4]	Fruits, young leaves	WJ (52)
Solanaceae	*Solanum melongena* L.	Kadui mbolo[1], terong bulat[4]	Fruits	WNT, Aceh (13)
Solanaceae	*Solanum torvum* Sw.	Takokak[2], rimbang/tekokak[4]	Fruits	WJ (73), Aceh (42)
Urticaceae	*Pilea melastomoides* (Poir.) Wedd.	Pohpohan[2,4]	Leaves	WJ (42)
Zingiberaceae	*Curcuma longa* L.	Kunyit[1,2,3,4]	Rhizomes	WNT (36), WJ (30), Aceh (24)
Zingiberaceae	*Etlingera elatior* (Jack) R.M.Sm.	Kecombrang[3], honje[2], kecombrang[4]	Flowers	Aceh (9), WJ (31)
Zingiberaceae	*Zingiber officinale* Roscoe	Jahe[1,2,3,4]	Rhizomes	WNT (24), WJ (45), Aceh (20)

Note: Data were collected in communities speaking [1]Bahasa Mbojo (Nggahi Mbojo, Bimanese; eastern Sumbawa, West Nusa Tenggara), [2]Bahasa Sunda (Sundanese; West Java), and [3]Bahasa Aceh (Basa Acèh, Acehnese; Aceh Province, Sumatra). When available, the names of TFPs in [4]Indonesian were also recorded.
WNT: West Nusa Tenggara; WJ: West Java. *Non-seeded type (sterile).

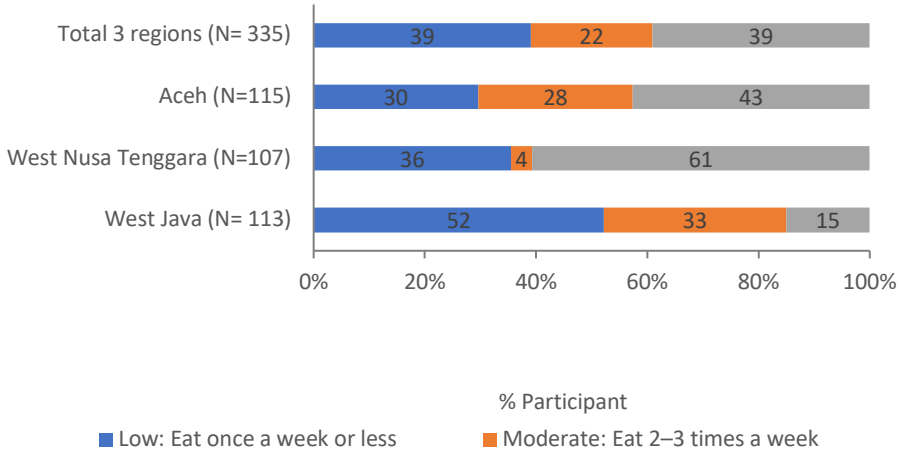

Figure 2. Traditional food plants' consumption frequency in the studied locations in West Java, West Nusa Tenggara, and Aceh.

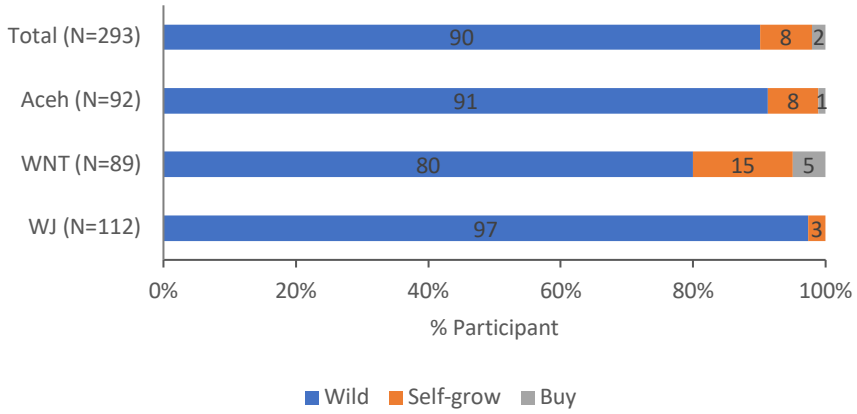

Figure 3. Traditional food plants' acquisition methods (excluding 'none' responses) in studied locations in West Java (N=112), West Nusa Tenggara (N=89), and Aceh (N = 92).

Table 3. Summary of variables showing significant bivariate associations between TFP consumption and socio-demographic/livelihood factors across the three study locations: West Java (N = 113), West Nusa Tenggara (N = 109), and Aceh (N = 115).

Location	Variable	Value (ρ/χ^2)	*p* value
West Java	Education level	-0.235	0.012
	[a]Being farmer	10.934	0.004
	Vegetables/fruits consumption	-0.679	0.000
	[a]Home gardening	11.435	0.003
	[a]Livestock rearing	40.818	0.000
	[a]Agricultural land access	15.779	0.000
West Nusa Tenggara	[a]Being farmer	8.019	0.018
	Expenditure	0.553	0.000
	Vegetables/fruits consumption	0.652	0.000
	[a]Livestock rearing	16.310	0.000

Aceh	BMI	0.625	0.000
	[a]Being farmer	6.479	0.039
	Expenditure	0.220	0.018
	Vegetables/fruits consumption	0.596	0.000
	[a]Home gardening	33.934	0.000
	[a]Livestock rearing	8.503	0.014
	[a]Agricultural land access	8.542	0.014

Note: Only significant associations ($p < 0.05$) are presented. Variables indicated with superscript ([a]) were tested using Chi-square (χ^2); all others were tested using Spearman's rank correlation (ρ).

Associations between TFP consumption and perceived well-being

Bivariate analysis revealed site-specific associations between TFP consumption and indicators of perceived well-being (HRQoL) (Table 4). Only statistically significant results ($p < 0.05$) are reported here. In West Java, a strong positive correlation was observed with *Social Functioning* (SF) (ρ = 0.71), a mental component of well-being. In WNT, positive correlations ranging from weak to moderate were identified with two physical components, *Bodily Pain* (BP) (ρ = 0.37) and *General Health* (GH) (ρ = 0.60), as well as two mental components, *Vitality* (VT) (ρ = 0.37) and *Mental Health* (MH) (ρ = 0.57). In Aceh, a negative correlation was found with *Physical Functioning* (PF) (ρ = -0.35), while weak positive correlations were observed with GH (ρ= 0.20 and with the mental component *Role of Emotional* (RE) (ρ = 0.20). The score of the perceived health and well-being assessment (HRQoL scale) using the SF-12 is presented in Supplementary Table 3.

Table 4. Bivariate correlation between TFP consumption and self-assessed well-being (HRQoL as proxy) (N=335).

HRQoL indicators	TFP consumption		
	West Java	West Nusa Tenggara	Aceh
	N=113	N=107	N= 115
Physical Component Summary/PCS			
Physical functioning (PF)	-	-	-0.35**
Role of physical functioning (RP)	-	-	-
Bodily pain (BP)	-	0.37**	-
General health (GH)	-	0.60**	0.20*
Mental Component Summary/MCS			
Vitality (VT)	-	0.37**	-
Role of emotion (RE)	-	-	0.20*
Social functioning (SF)	0.71**	-	-
Mental health (MH)	-	0.57**	-

Note: HRQoL: Health-Related Quality of Life. The values represent Spearman's Rho (ρ) correlation coefficients between TFP consumption and HRQoL indicators; Strong correlation: $0.7 < \rho < 0.9$; moderate correlation: $0.5 < \rho < 0.7$; weak correlation: $\rho < 0.3$. *, and **indicate significance at 0.05 and 0.01.

Subsequent multivariate analysis, controlling for age, BMI, education, chronic illness, diet, and livelihood (Table 5), revealed site-specific patterns. In West Java, the association between TFP consumption and SF remained significant (β = 0.366, $p < 0.001$), alongside vegetable/fruit consumption. In WNT, TFP consumption independently predicted both MH (β = 0.349, $p = 0.001$) and GH (β = 0.461, $p < 0.001$), in addition to age and expenditure. By contrast, BP and VT, which had shown significant associations in the bivariate analysis, were no longer significant after adjustment. In Aceh, the positive bivariate association

with GH reversed direction (β = -0.311, *p* = 0.009), reflecting confounding by age and BMI. PF and RE, which had been significant in the bivariate correlations, also lost significance after adjustment.

Table 5. Summary of TFP consumption's significance in multivariate models (adjusted for confounders).

Location	HRQoL Domain	Bivariate association with TFP consumption	Multivariate result for TFP consumption	Other significant predictors
West Java	SF	Yes (R = 0.71, p < 0.01)	**Remains significant** (β = 0.366, p < 0.001)	Vegetables/fruits (β = −0.363, p < 0.001)
West Nusa Tenggara	BP	Yes (R = 0.37, p < 0.01)	Not significant	Age (β = −0.243, p = 0.031) Being farmer (β = 0.210, p = 0.038)
	GH	Yes (R = 0.60, p < 0.01)	**Remains significant** (β = 0.461, p < 0.001)	Age (β = −0.259, p = 0.007), Expenditure (β = 0.171, p = 0.047)
	VT	Yes (R = 0.37, p < 0.01)	Not significant	—
	MH	Yes (R = 0.57, p < 0.01)	**Remains significant** (β = 0.349, p = 0.001)	—
Aceh	PF	Yes (R = −0.35, p < 0.01)	Not significant	Age (β = −0.318, p = 0.004) Chronic illness (β = −0.214, p = 0.015)
	GH	Yes (R = 0.20, p < 0.05)	**Significant but negative** (β = −0.311, p = 0.009)	Age (β = −0.219, p = 0.043) BMI (β = −0.464, p < 0.000) Education (β = 0.314, p = 0.006) Vegetables/fruits (β = 0.301, p = 0.002)
	RE	Yes (R = 0.20, p < 0.05)	Not significant	Age (β = −0.433, p < 0.000)

Discussion

Diversity of TFPs

Our survey identified 121 species across 49 families, indicating the resilience of TFP use in local food systems. Comparable Indonesian studies reported 52 unconventional food plants in Rancakalong, West Java, 85 wild food plants in Pasaman, West Sumatra (Pawera *et al.* 2020), 86 indigenous vegetables in Bali (Sujarwo *et al.* 2015), and 96 species in Kapuas Hulu, West Kalimantan (Haryanti & Diba 2015). In Southeast Asia, similar inventories documented 83 species in rural Southern Shan State, Myanmar (Shin *et al.* 2018), 110 species in Laos (Łuczaj *et al.* 2021), and 69 species in the Philippines (Ong & Kim 2017). Although the total number of species recorded across all sites in this study exceeds those reported in previous research, the per-site counts (36 in Aceh, 58 in West Java, and 60 in WNT) are consistent with or lower than single-site inventories. This outcome is consistent with our use of the FFQ, an ex situ elicitation method that records the species actually consumed during the recall period. Such methods generally yield shorter species lists than in-situ approaches, for example, 'walk-in-the-woods' surveys (Gallois *et al.* 2021, Quinlan 2005).

The high representation of *Cucurbitaceae* and *Fabaceae,* each contributing 12 species, highlights their significance in Indonesian and mainland Southeast Asian food systems. These families are valued for nutritional density, ease of cultivation, and resilience in home gardens and poor soils (Ebert 2014, Rahayu *et al.* 2024, Saensouk *et al.* 2025). In Java's Madurese community, Fabaceae have the greatest diversity, with species such as *Vigna unguiculata* (cowpea/**kacang tunggak**), *Psophocarpus tetragonolobus* (winged bean/**kecipir**), and *Tamarindus indica* (tamarind/**asam**) commonly grown as intercrops in traditional **Taneyan Lanjang** home gardens (Setiani *et al.* 2022). In East Aceh's coastal community, *Cucurbitaceae* is the most commonly used plant family in cooking (Nursamsu *et al.* 2025). Across sites, fruits (43%) and leaves (31%) are the most consumed plant parts, which aligns with their ease of harvest and suitability for local tastes. This pattern is similar to what other food ethnobotanical studies in Indonesia (Adnan *et al.* 2023, Hernawati *et al.* 2022, Lee *et al.* 2021, Navia *et al.* 2020, Rahayu *et al.* 2024, Sujarwo *et al.* 2025) and elsewhere (Pinela *et al.* 2017, Reyes-garcía *et al.* 2005, Wang *et al.* 2023, Zhang & Zhao 2020) have found. Although less common, people also use flowers, shoots, rhizomes, and mixed plant parts, reflecting detailed local knowledge. For instance, coconut heart (*humut*) is eaten as a seasonal delicacy in West Java (Rahayu *et al.* 2024).

Geographic differences in consumed-species diversity suggest that ecological conditions, livelihood strategies, and culinary traditions primarily determine food-plant use, rather than random foraging (Cruz *et al.* 2013, Ickowitz *et al.* 2016, Iskandar *et al.* 2023, Kuhnlein *et al.* 2009). In West Java, frequent consumption of leafy greens such as *Pilea melastomoides*,

Cnidoscolus aconitifolius, and *Limnocharis flava* aligns with the Sundanese *lalapan* tradition, which favors fresh greens, potentially influencing demand for a wide variety of edible leaves (Hernawati *et al.* 2022). In WNT, diets focus on starchy staples like *Colocasia esculenta* and *Ipomoea batatas*, as well as resilient leafy vegetables such as *Moringa oleifera*. These plants are well-suited to the area's long dry season and unpredictable rainfall, primarily affected by the El Niño Southern Oscillation (ENSO) (BMKG 2025, Kirono *et al.* 2016). Such conditions are known to favor drought-tolerant species, including *M. oleifera* (Mashamaite *et al.* 2024, Vijayaragavan *et al.* 2025) and taro cultivars like *Colocasia esculenta* (Ganança *et al.* 2018, Zhang *et al.* 2024). In Aceh, there is greater reliance on forest-proximate TFPs, especially wild fruits such as *Artocarpus integer, Musa acuminata, and Durio zibethinus,* as well as edible fern and rattan shoots. This corroborates other studies in the area that document a wide variety of native edible fruits and ongoing foraging in forested areas (Adnan *et al.* 2023, Suwardi *et al.* 2020b,2022). Similar forest-proximate diets with many wild fruits have been documented in eastern Bhutan, illustrating how forest access shapes TFP selection in daily diets (Yangdon *et al.* 2022).

The overlaps revealed a small set of widely shared TFP species, which are mostly spices. Chili (*Capsicum annuum*), turmeric (*Curcuma longa*), ginger (*Zingiber officinale*), and coconut (*Cocos nucifera*) form the base of many dishes across the archipelago. Indonesian cuisines are structured around spice pastes (bumbu), with chili central to sambal (chili paste) varieties, and turmeric and ginger used in many soups, curries, and herbal drinks (Estiasih *et al.* 2025, Fadiati *et al.* 2019, Surya & Tedjakusuma 2022). Coconut is equally foundational, appearing in dishes from Acehnese kuah pliek u, a fermented coconut-based soup, to Bimanese mangge mada, which uses banana blossom in fresh coconut milk (Akbar *et al.* 2024, Khathir *et al.* 2023). These widely used species are easy to cultivate and broadly available in markets (Rahmat *et al.* 2021), supporting their consistent use across sites. Our findings indicate that while a core of widely cultivated spices provides a common culinary foundation across Indonesia, the overall diversity of TFPs consumed is likely shaped by local ecology and food culture.

Patterns and correlates of TFP consumption

Global comparative works have demonstrated the context-specific use of traditional foods while also highlighting their shared importance (Bharucha & Pretty 2010, Kuhnlein *et al.* 2009). Accordingly, this study found differences and commonalities in TFP use patterns across sites. TFP consumption levels displayed distinct geographical patterns, with high-frequency users (at least four times a week) highest in WNT and lowest in West Java, which may reflect variations in local food environments (Sibhatu & Qaim 2018). However, when 'moderate' and 'high' categories are combined, TFP consumption is common among the study population in all three sites, as at least half of the participants reported moderate or higher intake. Our previous work in the Sumedang subdistrict of West Java also found that about 50% of participants consumed unconventional food plants two to three times per week, corresponding to the 'moderate' category in the present study (Rahayu *et al.* 2024). That many households consume TFPs several times per week suggests their continued relevance to the local diet, despite differences in socio-ecological settings. Wild and traditional foods remain important not only in agrarian and indigenous systems (Bharucha & Pretty 2010, Kuhnlein *et al.* 2009, Sakamoto *et al.* 2023a) but also in managed landscapes, such as paddy margins and home gardens in Southeast Asia (Cruz-García & Price 2014; Pawera et al. 2020). They are also present in urban and market settings, where wild species are still foraged and sold (Łuczaj et al. 2022; Sardeshpande et al. 2021).

The three study sites also shared a common sourcing pattern. Over 80% of participants collected non-cultivated TFPs from minimally managed places such as forests, **kebun** (mixed gardens), and **pematang sawah** (rice-field margins), referred to as 'wild areas' in this study. Although it was not reported in this study, households in rural Indonesia and elsewhere sometimes bring favored 'wild' species into home gardens to secure yield and ready access, which blurs the wild-cultivated boundary (Bvenura & Afolayan 2015, Hernawati *et al.* 2022, Pawera *et al.* 2020, Rahayu *et al.* 2020,2024, Septiani *et al.* 2020). Even so, across Southeast Asia and beyond, TFPs are gathered mainly from non-cultivated or unmanaged habitats (e.g., forests, hedgerows, fallows, and field bunds), rather than from planted plots (Adnan *et al.* 2023, Aryal *et al.* 2018, Cruz-Garcia & Price 2011, Luo *et al.* 2019, Rahayu *et al.* 2024). Our findings, along with these studies, suggest that wild and unmanaged spaces remain central sources of food, especially in remote and marginalized areas. Evidence from Southeast Asia also shows that when access to these landscapes is restricted by commercial agriculture or strict protection, wild-food use and diet quality decline (Broegaard *et al.* 2017). Global assessments further conclude that biodiversity, including wild food species and their habitats, is indispensable to food security (Pilling & Bélanger 2019). Thus, conserving these areas and securing community access is likely vital.

Factors associated with TFP consumption varied across the sites (Table 3). Indicators of land-based livelihoods, such as farming, livestock rearing, home gardening, and access to agricultural land, were associated with higher TFP intake across sites. Associations between TFP use and home gardening, as well as between TFP use and access to agricultural land, were evident in West Java and Aceh. Given that most TFPs are gathered in unmanaged lands, both land assets may simply indicate

greater engagement with surrounding landscapes, rather than sources. Comparable patterns were reported in Indonesia and northern Thailand, where villagers opportunistically gather wild plants along roadsides and trails on the way to fields or grazing areas (Rahayu *et al.* 2024, Roth 2004). Interestingly, these associations were not observed in WNT, where high overall use may leave slight between-household variation. The drier, more seasonal conditions in WNT may also help explain widespread reliance on uncultivated plants from unmanaged areas, which could make TFP use common regardless of garden or land access. Studies from seasonally dry settings in Timor Leste, Northeast Thailand, and Yunnan (among the Naxi people) have demonstrated that reliance on wild foods rises when rainfall is low or during the dry months (Erskine *et al.* 2015, Moreno-Black & Somnasang 2000, Zhang *et al.* 2016).

Across sites, the association between TFP intake and vegetable/fruit consumption is statistically significant, but the direction differs by context. In Aceh and WNT, the association was positive. Households that eat more vegetables and fruits (produce) also use more TFPs, suggesting a complementary pattern of use in the local diet. Despite their limited role in energy intake, wild and TFPs can help enhance dietary diversity and micronutrient intake, particularly in the diets of rural and Indigenous communities (Boedecker *et al.* 2014, Borelli *et al.* 2020, Mishra *et al.* 2021, Ogle *et al.* 2001a, Powell *et al.* 2015). In these settings, they are used alongside staple crops or commonly cultivated vegetables, typically as side dishes and seasonal additions, rather than as substitutes. A related diet indicator also points in the same direction in Aceh: BMI was positively associated with TFP intake. Considering that 37% of participants were underweight in Aceh (vs. 7% in West Java and 6% in WNT) (Supplementary Table 4), this pattern suggests that TFPs could be directed toward efforts to address undernutrition in the area. In West Java, by contrast, higher produce intake is linked with lower TFP use. This association may indicate a substitution (as opposed to 'complementary') by common produce in a more market-oriented setting. West Java is among Indonesia's most urbanized and economically developed areas, with deep market integration (Rahayu *et al.* 2020,2024). Our supplementary data shows 82% of participants obtained vegetables/fruits mainly by buying (Fig. S1). This context helps explain why West Java has the lowest share of frequent TFP users, aligning with broader evidence on dietary modernization, where increased market exposure often shifts consumption away from traditional foods (Colozza & Avendano 2019, Pawera *et al.* 2020, Zimmerer & Haan 2017). A parallel pattern in West Java is that education was negatively associated with TFP intake, acting as a proxy for market exposure and reinforcing the substitution seen with higher produce intake. Education shows a similar negative association only in West Java, which may also reflect greater exposure to purchased foods among more educated households, and is consistent with the substitution seen with higher produce intake.

Contrarily, expenditure was positively associated with TFP intake in WNT and Aceh. The association indicates that TFP use is not confined to the poorest households; participants with greater purchasing power also reported higher intake. This contrasts with the view that traditional or wild foods are mainly famine food or poor people's food (Deaconu *et al.* 2021). Similar findings have been reported elsewhere, where wild foods and environmental products contribute to diets and livelihoods not only among the poorest but also across wealth groups, reflecting cultural values and dietary preferences in addition to coping (Angelsen *et al.* 2014, Duguma 2020). Given the positive association with expenditure, it suggests that when TFPs are accessible and appealing in the market, households with more purchasing power may be more likely to choose them. Market-based strategies in promoting TFP use may therefore be effective in WNT and Aceh, while messaging and interventions should avoid framing TFPs as only safety-net foods. In West Java, however, education-linked preferences matter more than purchasing power, so that the effort could focus on knowledge transmission and desirability.

Linking TFP consumption and perceived well-being

Our findings contribute to the growing body of evidence on the role of TFP in Indonesia's food and public health system. Building on prior work that documents the nutrient value (Rahayu *et al.* 2024), we observe that higher TFP intake is also associated with perceived well-being, suggesting benefits that extend beyond diet. We also found that the link between TFP consumption and perceived well-being is context-dependent, echoing Tanzania's report, where associations with wild-food intake differed across semi-arid, forest-proximate, and peri-domestic settings (Sakamoto *et al.* 2023b).

In West Java, TFP intake showed a strong, positive association with *Social Functioning* (SF), an MCS domain that measures how health impacts social activities (Ware *et al.* 1995). Ethnographic data in Sumedang Subdistrict suggest that TFP use was motivated by personal and social factors rooted in Sundanese food culture (Rahayu *et al.* 2024). For instance, the tradition of eating lalapan, fresh raw vegetables, is both dietary and social (Hernawati *et al.* 2022, Rahayu *et al.* 2024). At **botram**, the Sundanese potluck-style feast, **lalapan** or TFP-based dishes are often shared. Such commensality has been described as reinforcing kinship and neighborhood ties, with shared foods serving as a form of social capital (Bourdieu 1986, Fischler 2011). Similar communal dining traditions across Indonesia, such as the Javanese slametan, North Sulawesi pesta feasts, and Sasak begibung, also show how food maintains collective bonds (Koentjaraningrat 1985, Sukenti *et al.* 2016, Weichart 2008).

Our field observations are consistent with this, illustrating how TFPs may facilitate social interaction. For example, a weekly makeshift market appeared in front of the **kantor kecamatan** (subdistrict office), where residents obtained TFPs and engaged in informal exchanges. Given TFP's social embeddedness in eating traditions and local market practices, the association between TFPs and SF in West Java may reflect social dynamics rooted in local culture (Rahayu 2024). Doran (2024) and Wang et al. (2024) link culturally embedded foods to subjective well-being through identity and shared meaning, with less emphasis on functional capacity. For West Java, this association suggests that supporting TFP-based communal traditions could help to bolster social well-being.

In WNT, TFP intake showed strong associations with both *General Health* (GH; a PCS domain) and *Mental Health* (MH; an MCS domain). These associations persisted after adjusting for confounders such as expenditure, occupation, and dietary factors, indicating that TFP intake is an independent predictor of well-being. This suggests that in WNT, regular TFP use may support both physical and mental aspects of well-being (Boedecker *et al.* 2014, Kuhnlein *et al.* 2009, Roche *et al.* 2008, Sakamoto *et al.* 2023b). While causality cannot be inferred, these associations are consistent with WNT's distinctive TFP use pattern, characterized by the frequent consumption (the highest across sites) of nutrient-dense species collected from unmanaged habitats. In this harsher, drier environment, TFPs such as **kelor** (*M. oleifera*), **ubi** (*I. batatas*), and **pare** (*M. charantia*) may serve as a nutritional buffer. Many wild or TFPs are not only rich in micronutrients but also have recognized medicinal uses (de Medeiros *et al.* 2021, Pinela *et al.* 2017). For example, the popularly consumed *M. oleifera* is reported to be a source of protein, fiber, iron, and vitamin C, with a particularly high calcium content (Rahayu *et al.* 2024). It is also used simultaneously for toothaches and headaches (Rahayu *et al.* 2020). Thus, TFPs may have helped maintain physical health directly through dietary improvements and medicinal properties. The link to MH is more challenging to interpret. It is unclear whether TFP intake directly impacts mental health. Routine exposure to nature while foraging and the self-reliance gained from utilizing local resources could potentially reinforce psychological resilience, which might be linked to better MH scores (Blanchet *et al.* 2021, Rosa *et al.* 2021). However, it is equally plausible that individuals with better health assessments (higher GH and MH scores) are more able to forage for TFP. Regardless of the reasons and outcomes, the significant association between these multiple domains of well-being in WNT underscores the importance of safeguarding access to these plants, including encouraging the cultivation of drought-resistant varieties.

Aceh presented a more complex picture. In the bivariate models, TFP consumption was positively correlated with GH and *Role of Emotional* (RE; an MCS domain). After adjustment, these links disappeared, and the GH coefficient turned negative ($\beta = -0.311$, $p = 0.009$; Table 5). In Tanzania, Sakamoto et al. (2023b) reported a similar negative association in areas where wild foods grow near homes, possibly reflecting exposure to toxic species and to soil or water contamination around households. Since such hazards were neither observed nor reported at our sites, the GH reversal is more likely a sample composition effect than a harmful one. TFP users tend to be older, and older participants tend to report lower GH. Once age is accounted for, it appears to outweigh positive associations with BMI, schooling, and diet variety (Table 5). This pattern could be consistent with an indirect pathway in which TFP use co-occurs with more varied diets and better nutritional status (higher BMI within the non-obese range), both of which are associated with higher GH. Evidence from India and China also indicates that perceived well-being is lower among underweight individuals and improves as their BMI increases beyond the underweight range (Selvamani & Singh 2018, Zhu *et al.* 2015). As mentioned, Aceh has the highest proportion of participants with low BMI among the three regions (Supplementary Table 4). It is among the top 10 provinces with the highest prevalence of stunting at 29.4% above the national average of 21.7% (Kemenkes RI 2023). Given the high prevalence of undernutrition and the strong BMI-GH correlation (Table 5), encouraging the use of nutrient-dense TFPs alongside energy-adequate staples in Aceh remains a potentially valuable strategy.

Implications for the study area

The findings of this study suggest the significant potential of TFPs to enhance food and nutrition security, cultural preservation, and public health in the study area. Given the nutritional value of many TFPs (Penafiel *et al.* 2011, Rahayu *et al.* 2024), their sustained consumption could be leveraged to address nutrient deficiencies, particularly in areas such as Aceh and WNT, where stunting rates exceed the national average (Kemenkes RI 2023). However, the distinct geographical preferences observed highlight the need to tailor promotion efforts to the specific context. National initiatives, such as the free seedling distribution program under the Ministry of Environment and Forestry's (KLHK) permanent nurseries (KLHK RI 2020), could be tailored to align with local dietary traditions and ecologies—such as focusing on leafy greens in West Java, resilient staples in WNT, and forest fruits in Aceh. Furthermore, the site-specific factors influencing TFP use and their unique associations with perceived well-being call for tailored intervention strategies.

In West Java, the link between TFP intake and the social dimension of well-being suggests consumption is deeply embedded in cultural identity and social interaction. This finding, coupled with the area's high market integration, suggests the potential benefits of strengthening the social ecosystems that support TFP use, from informal gatherings to local markets. This could include strengthening social rituals through initiatives that celebrate TFP-centric food culture, such as a community culinary festival. Similar interventions have been reported in Türkiye, where the Alaçatı Herb Festival showcases wild edibles through workshops, tastings, walks, and curated stalls, aiming to build demand and promote their incorporation into diets (Borelli *et al.* 2022). Simultaneously, it may be beneficial to leverage local markets as social hubs by promoting TFPs through venues such as community-supported agriculture programs, e.g., Tani Sauyunan, the Seni Tani community in West Java (Aulia Oktadino Azre 2023). In these settings, TFPs can be framed as desirable, high-quality foods that connect people to local culture and sustainable practices, an approach that aligns with the finding that higher education is associated with TFP intake in this area.

In WNT, the positive association with both General and Mental Health highlights a potential dual benefit, without implying causality. Here, it appears crucial to ensure reliable access to nutrient-dense, drought-tolerant species, such as *M. oleifera*. Because home gardening and land access were not associated with TFP intake in WNT, priorities might center on equitable access from shared landscapes, using communal resource management, sustainable harvesting rules, and simple processing and storage (Yangdon *et al.* 2022). Moreover, since higher expenditure in WNT predicts greater TFP intake, market integration could be encouraged by framing these foods as desirable choices rather than mere safety nets. This mix of communal access, modest cultivation, and market integration could buffer seasonal scarcity and potentially support psychological resilience through greater self-reliance (Bharucha & Pretty 2010, Kuhnlein 2014, Powell *et al.* 2011,2015).

In Aceh, despite complex statistical relationships, the positive correlation between TFP consumption and BMI, against a backdrop of high undernutrition, suggests a potential opportunity. TFPs could be integrated into existing national platforms **(Posyandu** counseling, **B2SA** campaigns) and paired with energy-adequate staples to close local nutrient gaps. **Posyandu** is a broad, routine platform for nutrition counseling for children and mothers, and **B2SA** (**Beragam, Bergizi, Seimbang, Aman**) is an active national movement to promote diverse, balanced, and safe diets; both could carry context-specific TFP messages (BPN RI 2025, Kemenkes RI 2011). Integrating local foods into primary health care and community nutrition education has been shown to improve diet quality and, in some cases, micronutrient adequacy (Susanto *et al.* 2017, Verbowski *et al.* 2018). Similarly, as in WNT, the positive link with expenditure in Aceh suggests that supporting market channels for forest fruits and other local TFPs might increase their consumption, leveraging purchasing power to improve dietary diversity.

Finally, these context-specific strategies should be underpinned by protecting the natural landscapes from which people obtain most of their TFPs. This goal can be directly supported by integrating TFP conservation into the Ministry of Environment and Forestry (KLHK) agenda, particularly within Social Forestry (**Perhutanan Sosial**) schemes, including **Hutan Desa** (Village Forrest), which explicitly supports community use (including non-timber forest products) (KLHK RI 2025). Furthermore, the consistent correlation between agricultural livelihoods and TFP intake across all sites underscores the potential value of promoting agrobiodiverse farming systems (home gardens, agroforestry, mixed cropping). Global syntheses link agricultural/landscape biodiversity with improved diet quality, reinforcing policies that back diverse production and access (Johns & Eyzaguirre 2006, Powell *et al.* 2015). By aligning interventions with geographic patterns and leveraging existing government platforms, TFPs could be strategically deployed to advance health, nutrition, and community resilience across Indonesia's diverse landscapes.

This study has several limitations. First, the use of an FFQ as an ex-situ elicitation tool, without an accompanying in-situ 'walk-in-the-woods' survey, likely resulted in an underreporting of total TFP diversity. The 'walk-in-the-woods' method assesses plant knowledge within its ecological context, yielding more detailed information than ex-situ surveys like FFQs (Gallois *et al.* 2021). While the FFQ can identify consumed species, it cannot capture the full diversity of known plants nor provide real-time data on the precise contribution of TFPs to the diet. A key strength of the FFQ, however, is its ability to account for consumption variation over a longer timeframe, capturing patterns for plants not consumed daily (Boedecker *et al.* 2014). Future research should employ mixed-method approaches, such as combining FFQs with 24-hour food recalls. The second limitation is the potential for recall bias and subjectivity in the self-reported HRQoL measures (Ware *et al.* 1995, Wicaksana *et al.* 2020). Future research could address this by complementing such tools with other forms of health evaluation to further validate the findings. Third, there is potential for unmeasured confounding variables. While the factors included were based on literature and local context, potential influential variables such as cultural attitudes, taste preferences, intergenerational knowledge transmission, and specific market dynamics were not quantitatively measured, resulting in an incomplete picture

(Rahayu *et al.* 2024, Sakamoto *et al.* 2023b). A mixed-methods approach would be beneficial to capture these qualitative dimensions. Fourth, the cross-sectional design limits our ability to make causal inferences about the relationships between TFP consumption, socio-economic factors, and perceived well-being (Wang & Cheng 2020). The results should therefore be interpreted as associations rather than definitive causal pathways, highlighting the need for longitudinal designs in future research. Finally, the findings are highly context-specific, as evidenced by the divergent correlates and well-being associations across the three study sites. This limits the direct generalizability of the results to other Indonesian provinces or similar socio-ecological contexts. Replicating this research in other areas is advisable to gather more comprehensive information.

Conclusion

This study illustrates the persistent and significant role of TFPs in the food systems of three distinct Indonesian provinces. By documenting 121 consumed species, this study confirms the remarkable TFP diversity integrated into the local diet, which is primarily sourced from unmanaged landscapes, such as forests, field margins, and mixed gardens. Geographical differences in TFPs consumed appear to be shaped by local ecology and cultural contexts. West Java's consumption is characterized by leafy greens aligned with the lalapan tradition. At the same time, WNT's is defined by drought-resilient staples suited to its dry climate, and Aceh's by a reliance on forest-proximate fruits and shoots.

Beyond inventory, this study suggests that TFPs are incorporated into weekly diets and are linked to perceived well-being, although the nature of this relationship is context-dependent. In West Java, TFPs are strongly linked to social functioning, supporting the view of their cultural embeddedness. In WNT, consumption is associated with both general and mental health perceptions, pointing to a potential dual benefit in a more challenging environment. In Aceh, the positive association between TFP intake and BMI, within a context of high undernutrition, highlights their potential value for nutritional interventions. The factors influencing TFP consumption further emphasize the need for tailored approaches. While land-based livelihoods consistently predict higher intake, the roles of market integration, education, and wealth vary. The finding that higher expenditure is associated with greater TFP use in Aceh and WNT challenges the perception of these foods as merely a 'safety net' for the poor, suggesting that they have cultural and dietary value across wealth groups.

Therefore, promoting TFPs represents a potentially valuable approach to enhancing nutrition, cultural preservation, and community resilience. However, effective strategies must be context-sensitive, with location-specific priorities such as reinforcing social foodways in West Java, securing access to nutrient-dense species in WNT, and integrating TFPs into nutrition programs to address undernutrition in Aceh. Underpinning all these efforts should be a commitment to conserving the wild and semi-wild habitats that are the primary sources of these foods. Furthermore, the consistent link between agricultural livelihoods and TFP use underscores the importance of agrobiodiversity. Promoting diverse farming systems—such as home gardens, agroforestry, and mixed cropping—is an important strategy to sustain the landscape heterogeneity that supports these valuable species. By aligning interventions with these distinct regional patterns and leveraging existing government platforms, TFPs could be strategically advanced to support health, well-being, and sustainable food systems across Indonesia's diverse landscapes.

Declarations

List of abbreviations: TFP - Traditional Food Plant**;** WNT - West Nusa Tenggara; SF-12 - Short Form-12; HRQoL - Health-Related Quality of Life; FFQ - Food Frequency SF-36 - Short Form-36; PCS - Physical Component Summary; MCS - Mental Component Summary; PF- Physical Functioning; RP - Role Physical; BP - Body Pain; GH - General Health; VT - Vitality; SF - Social Functioning; RE - Role Emotional; MH - Mental Health; BMI - Body Mass Index

Ethics approval and consent to participate: The study was conducted in accordance with the International Society of Ethnobiology Code of Ethics (ISE 2008) and ethical standards for research involving human subjects, with ethical approval obtained from the Ministry of Health, Bandung Health Polytechnic, Indonesia (No. 05/KEPK/EC/V/2023). Verbal and written consent were obtained prior to the interviews, and the nature and purpose of the research were clearly explained to the participants.

Consent for publication: Not applicable

Availability of data and materials: Data will be made available on request.

Competing interests: Not applicable

Funding: The research was supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI (Grant Number 24K20988), the Sumitomo Foundation (Grant Number 24802042), and the National Research and Innovation Agency (BRIN)

Author contributions: Y.Y.S.R. conceptualized and designed the study, collected and analyzed the data, wrote the first draft, and was responsible for reviewing, editing, and finalizing the manuscript. A.B.S. and A.A. contributed to data collection and

the writing of the original draft. A.S.D.I. conducted plant identification. R.M.P. contributed to data analysis. W.S. reviewed the final drafts. All authors have read and approved the final version.

Acknowledgements

We thank everyone who contributed to this study and shared their knowledge and expertise.

Literature cited

Adnan, Navia ZI, Jamil M, Suwardi AB. 2023. The diversity and traditional knowledge of wild edible vegetables in Aceh, Indonesia. Ethnobotany Research and Applications 26: 1-16. doi: 10.32859/era.26.49.1-16.

Afrianto WF, Hasanah LN, Metananda AA. 2024. Diversity of edible plants traded in the East Jakarta traditional markets, Indonesia. Biodiversitas Journal of Biological Diversity 24(12): 6953-6968. doi: 10.13057/biodiv/d241257.

Ahmad K, Pieroni A. 2016. Folk knowledge of wild food plants among the tribal communities of Thakht-e-Sulaiman Hills, North-West Pakistan. Journal of Ethnobiology and Ethnomedicine 12: 17. doi: 10.1186/s13002-016-0090-2.

Akbar MR, Hanafi SH, Widayati U. 2024. Identification Of Bima Culinary Lexicon As An Effort To Preserve The Bima Language: An Ethnolinguistic Review. In : *The 4th International Conference of Humanities and Social Sciences*; 2024 Dec 4; Surakarta: Indonesia Language Education Doctoral Program Alumni Association Universitas Sebelas Maret. Pp. 711- 724.

Angelsen A, Jagger P, Babigumira R, Belcher B, Hogarth NJ, Bauch S, Borner J, Smith-Hall C, Wunder S. 2014. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. World Development 64(S1): S12-S28. doi: 10.1016/j.worlddev.2014.03.006.

Ani N, Sukenti K, Aryanti E, Rohyani IS. 2021. Ethnobotany Study of Medicinal Plants by the Mbojo Tribe Community in Ndano Village at the Madapangga Nature Park, Bima, West Nusa Tenggara. Jurnal Biologi Tropis 21(2): 456-469. doi: 10.29303/jbt.v21i2.2666.

Aryal KP, Poudel S, Chaudhary RP, Chettri N, Chaudhary P, Ning W, Kotru R. 2018. Diversity and use of wild and non-cultivated edible plants in the Western Himalaya. Journal of Ethnobiology and Ethnomedicine 14(1): 1-18. doi: 10.1186/s13002-018-0211-1.

Azre AO. 2023.Community Supported Agriculture in Indonesia: Opportunities and Limitations, Study Case: Seni Tani in Bandung, Indonesia. PhD dissertation, University of Reading.

Bharucha Z, Pretty J. 2010. The roles and values of wild foods in agricultural systems. Philosophical Transactions of the Royal Society B: Biological Sciences 365(1554): 2913-2926. doi: 10.1098/rstb.2010.0123.

Blanchet R, Batal M, Johnson-Down L, Johnson S, Willows N. 2021. An Indigenous Food Sovereignty Initiative Is Positively Associated With Well-Being and Cultural Connectedness in a Survey of Syilx Okanagan Adults in British Columbia, Canada. BMC Public Health 21: 1. doi: 10.1186/s12889-021-11229-2.

BMKG.Buletin Iklim NTB. 2023. https://staklim-ntb.bmkg.go.id (Accessed 25/6/2025).

Boedecker J, Termote C, Assogbadjo AE, Van Damme P, Lachat C. 2014. Dietary contribution of wild edible plants to women's diets in the buffer zone around the Lama forest, Benin - an underutilized potential. Food Security 6(6): 833-849. doi: 10.1007/s12571-014-0396-7.

Borelli T, Güzelsoy NA, Hunter D, Tan A, Karabak S, Uçurum H, Çavuş F, Ay ST, Adanacıoğlu N, Özbek K, Özen B, Tokat E, Taşçı R. 2022. Assessment of the Nutritional Value of Selected Wild Food Plants in Türkiye and Their Promotion for Improved Nutrition. Sustainability 14(17): 11015. doi: 10.3390/su141711015.

Borelli T, Hunter D, Powell B, Ulian T, Mattana E, Termote C, Pawera L, Beltrame D, Penafiel D, Tan A, Taylor M, Engels J. Born to Eat Wild: An Integrated Conservation Approach to Secure Wild Food Plants for Food Security and Nutrition. Plants 9(10): 1299. doi: 10.3390/plants9101299.

Bourdieu P. 1986. The Forms of Capital. In: Richardson J. (ed). Handbook of Theory and Research for the Sociology of Education. Greenwood, New York, US, Pp. 241-258.

BPN RI. Gerakan Penganekaragaman Konsumsi Pangan Beragam, Bergizi, Seimbang dan Aman (B2SA). 2025. https://badanpangan.go.id (Accessed 10/8/2025).

BPS. Titik Koordinat Wilayah Kecamatan di Kota Bandung. 2024a. https://opendata.bandung.go.id (Accessed 11/8/2025).

BPS. *Kabupaten Bandung Barat Dalam Angka.* Bandung: BPS Kabupaten Bandung Barat, 2024b.

BPS. *Kecamatan Tamiang Hulu Dalam Angka*. Aceh Tamiang: BPS Aceh Tamiang, 2024c.

BPS. *Kabupaten Bima Dalam Angka*.Bima : BPS Kabupaten Bima, 2024d.

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

Bvenura C, Afolayan AJ. 2015. The role of wild vegetables in household food security in South Africa: A review. Food Research International 76(P4): 1001-1011. doi: 10.1016/j.foodres.2015.06.013.

CBD. Indonesia - Country Profile Biodiversity Facts. 2025. Convention on Biological Diversity. https://www.cbd.int (Accessed 4/7/2025).

Colozza D, Avendano M. 2019. Urbanisation, dietary change and traditional food practices in Indonesia: A longitudinal analysis. Social Science & Medicine 233: 103-112. doi: 10.1016/j.socscimed.2019.06.007.

Cooper M, Zvoleff A, Gonzalez-Roglich M, Tusiime F, Musumba M, Noon M, Alele P, Nyiratuza, M. 2018. Geographic factors predict wild food and nonfood NTFP collection by households across four African countries. Forest Policy and Economics 96: 38-53. doi: 10.1016/j.forpol.2018.08.002.

Cruz MP, Peroni N, Albuquerque UP. 2013. Knowledge, use and management of native wild edible plants from a seasonal dry forest (NE, Brazil). Journal of Ethnobiology and Ethnomedicine 9(1): 1-10. doi: 10.1186/1746-4269-9-79.

Cruz-Garcia GS, Price LL. 2011. Ethnobotanical investigation of "wild" food plants used by rice farmers in Kalasin, Northeast Thailand. Journal of Ethnobiology and Ethnomedicine 7: 33. doi: 10.1186/1746-4269-7-33.

de Medeiros PM, Figueiredo KF, Gonçalves PHS, Caetano R de A, Santos ÉM da C, Santos GMC dos, Barbosa DM, Paula M de, Mapeli AM. 2021. Wild plants and the food-medicine continuum—an ethnobotanical survey in Chapada Diamantina (Northeastern Brazil). Journal of Ethnobiology and Ethnomedicine 17: 37. doi: 10.1186/s13002-021-00463-y.

Deaconu A, Mercille G, Batal M. 2021. Promoting traditional foods for human and environmental health : lessons from agroecology and Indigenous communities in Ecuador. BMC Nutrition 7(1): 1-14. doi: 10.1186/s40795-020-00395-y.

Doran N. 2024. Defining cultural-ecological resilience through community and sovereign food systems. Ecology and Society 29(4): 25. doi: 10.5751/ES-15323-290425.

Duguma HT. 2020. Wild Edible Plant Nutritional Contribution and Consumer Perception in Ethiopia. International Journal of Food Science e2958623: 1-16. doi: 10.1155/2020/2958623.

Ebert A. 2014. Potential of Underutilized Traditional Vegetables and Legume Crops to Contribute to Food and Nutritional Security, Income and More Sustainable Production Systems. Sustainability 6(1): 319-335. doi: 10.3390/su6010319.

Erber E, Beck L, Hopping B, Sheehy T, Roose ED, Sharma S. 2010. Food Patterns and Socioeconomic Indicators of Food Consumption Amongst Inuvialuit in the Canadian Arctic. Journal of Human Nutrition and Dietetics 23(1): 59-66. doi: 10.1111/j.1365-277x.2010.01097.x.

Erskine W, Ximenes A, Glazebrook D, Da Costa M, Lopes M, Spyckerelle L, Williams R, Nesbitt H. 2015. The role of wild foods in food security: the example of Timor-Leste. Food Security 7(1): 55-65. doi: 10.1007/s12571-014-0406-9.

Estiasih T, Maligan JM, Witoyo JE, Mu'alim AAH, Ahmadi K, Mahatmanto T, Zubaidah E. 2025. Indonesian traditional herbal drinks: diversity, processing, and health benefits. Journal of Ethnic Foods 12(1): 7. doi: 10.1186/s42779-025-00267-5.

Fadiati A. 2019. Codification of Indonesian Culinary: Critical Analysis of Traditional Food. In: *3rd UNJ International Conference on Technical and Vocational Education and Training* 2018. KnE Social Sciences. Pp. 19-31. doi: 10.18502/kss.v3i12.4070.

Fischler C. 2011. Commensality, society and culture. Social Science Information 50(3-4): 528-548. doi: 10.1177/0539018411413963.

Fitrahtunnisa, Mardian I, Rahmatullaila. 2020. Performance and utilization of local sorghum (*Sorghum bicolor* L.) in West Nusa Tenggara. IOP Conference Series: Earth and Environmental Science 484(1): 012092. doi: 10.1088/1755-1315/484/1/012092.

Flyman MV, Afolayan AJ. 2006. The suitability of wild vegetables for alleviating human dietary deficiencies. South African Journal of Botany 72(4): 492-497. doi: 10.1016/j.sajb.2006.02.003.

Gallois S, Heger T, Henry AG, van Andel T. 2021. The importance of choosing appropriate methods for assessing wild food plant knowledge and use: A case study among the Baka in Cameroon. PLoS ONE 16(2): e0247108. doi: 10.1371/journal.pone.0247108.

Ganança JFT, Freitas JGR, Nóbrega HGM, Rodrigues V, Antunes G, Gouveia CSS, Rodrigues M, Chaïr H, de Carvalho MAAP, Lebot V. 2018. Screening for Drought Tolerance in Thirty Three Taro Cultivars. Notulae Botanicae Horti Agrobotanici Cluj-Napoca 46(1): 65-74. doi: 10.15835/nbha46110950.

Govindaraju T, Sahle B, McCaffrey T, McNeil J, Owen A. 2018. Dietary Patterns and Quality of Life in Older Adults: A Systematic Review. Nutrients 10(8): 971. doi: 10.3390/nu10080971.

Guyatt GH, Feeny DH, Patrick DL. 1993. Measuring Health-Related Quality of Life. Annals of Internal Medicine 118(8): 622-629. doi: 10.7326/0003-4819-118-8-199304150-00009.

Haryanti ES, Diba F. 2015. Etnobotani tumbuhan berguna oleh masyarakat sekitar kawasan KPH model Kapuas Hulu. Jurnal Hutan Lestari 3(3): 434-445.

Hernawati D, Putra RR, Meylani V. 2022. Indigenous vegetables consumed as lalapan by Sundanese ethnic group in West Java, Indonesia: Potential, traditions, local knowledge, and it's future. South African Journal of Botany 151: 133-145. doi: 10.1016/j.sajb.2022.09.007.

Hetherington JB, Wiethoelter AK, Negin J, Mor SM. 2017. Livestock ownership, animal source foods and child nutritional outcomes in seven rural village clusters in Sub-Saharan Africa. Agriculture & Food Security 6(1): 9. doi: 10.1186/s40066-016-0079-z.

Hickey GM, Pouliot M, Smith-Hall C, Wunder S, Nielsen MR. 2016. Quantifying the economic contribution of wild food harvests to rural livelihoods: A global-comparative analysis. Food Policy 62: 122-132. doi: 10.1016/j.foodpol.2016.06.001.

Hunter D, Borelli T, Beltrame DMO, Oliveira CNS, Coradin L, Wasike VW, Wasilwa L, Mwai J, Manjella A, Samarasinghe GWL, Madhujith T, Nadeeshani HPH, Tan A, Ay ST, Güzelsoy N, Lauridsen N, Gee E, Tartanac F. 2019. The potential of neglected and underutilized species for improving diets and nutrition. Planta 250(3): 709-729. doi: 10.1007/s00425-019-03169-4.

Ickowitz A, Rowland D, Powell B, Salim MA. 2016. Forests, Trees, and Micronutrient-Rich Food Consumption in Indonesia. 11(5): e0154139. doi: 10.1371/journal.pone.0154139.

Iskandar BS, Irawan B, Mulyanto D, Iskandar J, Afinanda A, Rajab B. 2023. Gastronomic ethnobotany of traditional vegetables among the Sundanese in rural West Java, Indonesia. Biodiversitas Journal of Biological Diversity 24 (7): 3932-3950. doi: 10.13057/biodiv/d240732.

Johns T, Eyzaguirre PB. 2006. Linking biodiversity, diet and health in policy and practice. Proceedings of the Nutrition Society 65(2): 182-189. doi: 10.1079/pns2006494.

Kemenkes RI. *Pedoman Umum Pengelolaan Posyandu*. Jakarta: Kementerian Kesehatan RI, 2011.

Kemenkes RI. *Stunting in Indonesia and Its Determinants*. Jakarta: Kementerian Kesehatan RI, 2023.

Kennedy G, Kanter R, Chotiboriboon S, Covic N, Delormier T, Longvah T, Maundu P, Omidvar N, Vish P, Kuhnlein H. 2021. Traditional and Indigenous Fruits and Vegetables for Food System Transformation. Current Developments in Nutrition 5(8): nzab092. doi: 10.1093/cdn/nzab092.

Khathir R, Muzaifa M, Yunita, Rahmawati M. 2023. Study on the physicochemical and sensory profile of *pliek-u*: A traditional dried fermented coconut endosperm from Aceh, Indonesia. AIMS Agriculture and Food 8(2): 534-549. doi: 10.3934/agrfood.2023028.

Kirono DGC, Butler JRA, McGregor JL, Ripaldi A, Katzfey J, Nguyen K. 2016. Historical and future seasonal rainfall variability in Nusa Tenggara Barat Province, Indonesia: Implications for the agriculture and water sectors. Climate Risk Management 12: 45-58. doi: 10.1016/j.crm.2015.12.002.

KLHK RI. Bibit Gratis untuk Seluruh Indonesia. 2020. https://pdasrh.menlhk.go.id (Accessed 9/8/2025).

KLHK RI. Perhutanan Sosial. 2025. https://www.menlhk.go.id/ (Accessed 9/8/2025).

Koentjaraningrat. 1985.Javanese Culture.Oxford University Press, California, US.

Krisnawan GD, Chang Y-L, Tsai F, Tseng K-H, Lin T-H. 2025. Meteorological Drivers and Agricultural Drought Diagnosis Based on Surface Information and Precipitation from Satellite Observations in Nusa Tenggara Islands, Indonesia. Remote Sensing 17(14): 2460. doi: 10.3390/rs17142460.

Kuhnlein H, Erasmus B, Creed-Kanashiro H, Englberger L, Okeke C, Turner N, Allen L, Bhattacharjee L. 2006. Indigenous peoples' food systems for health: finding interventions that work. Public Health Nutrition 9(8): 1013-1019. doi: 10.1017/PHN2006987.

Kuhnlein HV. 2014. Food system sustainability for health and well-being of Indigenous Peoples. Public Health Nutrition 18(13): 2415-2424. doi: 10.1017/S1368980014002961.

Kuhnlein HV, Chotiboriboon S. 2022. Why and How to Strengthen Indigenous Peoples' Food Systems With Examples From Two Unique Indigenous Communities. Frontiers in Sustainable Food Systems 6: 808670. doi: 10.3389/fsufs.2022.808670.

Kuhnlein HV, Erasmus B, Spigelski D. *Indigenous Peoples' Food Systems: The Many Dimensions of Culture, Diversity and Environment for Nutrition and Health*.Rome: FAO, 2009. doi: 10.4060/cb5131en.

Kuhnlein HV, Receveur O. 1996. Dietary Change and Traditional Food Systems of Indigenous Peoples. Annual Review of Nutrition 16(1): 417-442. doi: 10.1146/annurev.nu.16.070196.002221.

Lee SM, Nichols JD, Lloyd D, Sagari S, Sagulu F, Siregar IZ, Permatasari A, Hartoyo P, Henry R. 2021. The indigenous uses of plants from Siberut, Mentawai, Indonesia. Ethnobotany Research and Applications 22 : 1-33. http://dx.doi.org/10.32859/era.22.18.1-33.

Leite A, Westengen OT, Catarino L, Monteiro E, Mango SP, Indjai B, Cuní-Sanchez A. 2024. From the Wild to the Market: The Trade of Edible Plants in Guinea-Bissau. Economic Botany 78(4): 390-408. doi: 10.1007/s12231-024-09614-0.

Łuczaj Ł, Lamxay V, Tongchan K, Xayphakatsa K, Phimmakong K, Radavanh S, Kanyasone V, Pietras M, Karbarz M. 2021. Wild food plants and fungi sold in the markets of Luang Prabang, Lao PDR. Journal of Ethnobiology and Ethnomedicine 17: 1. doi: 10.1186/s13002-020-00423-y.

Luo B, Liu B, Zhang H, Zhang H, Li X, Ma L, Wang Y, Bai Y, Zhang X, Li J, Yang J, Long C. 2019. Wild edible plants collected by Hani from terraced rice paddy agroecosystem in Honghe Prefecture, Yunnan, China. Journal of Ethnobiology and Ethnomedicine 15(1): 56. doi: 10.1186/s13002-019-0336-x.

Luo B, Tong Y, Liu Y, Zhang Y, Qin Y, Hu R. 2024. Ethnobotanical insights into the traditional food plants of the Baiku Yao community: a study of cultural significance, utilization, and conservation. Journal of Ethnobiology and Ethnomedicine 20(1): 52. doi: 10.1186/s13002-024-00691-y.

Mashamaite CV, Ramatsitsi MN, Manyevere A. 2024. Moringa oleifera Lam.: A versatile climate-smart plant for nutritional security and therapeutic usage in semi-arid regions. Journal of Agriculture and Food Research 16: 101217. doi: 10.1016/j.jafr.2024.101217.

Mcelwee PD. 2008. Forest environmental income in Vietnam: household socioeconomic factors influencing forest use. Environmental Conservation 35(2): 147-159. doi: 10.1017/S0376892908004736.

Mishra A, Swamy SL, Thakur TK, Bhat R, Bijalwan A, Kumar A. 2021. Use of wild edible plants: Can they meet the dietary and nutritional needs of indigenous communities in Central India. Foods 10(7): e1453. doi: 10.3390/foods10071453.

Monterrosa EC, Frongillo EA, Drewnowski A, De Pee S, Vandevijvere S. 2020. Sociocultural Influences on Food Choices and Implications for Sustainable Healthy Diets. Food and Nutrition Bulletin 41(2): 59S-73S. doi: 10.1177/0379572120975874.

Moreno-Black G, Somnasang P. 2000. In times of plenty and times of scarcity: Nondomesticated food in northeastern Thailand. Ecology of Food and Nutrition 38(6): 563-586. doi: 10.1080/03670244.2000.9991597.

Murdhani LA, Mujahidin M, Wahyudi E, Marzuki M. 2025. Diversification of Beneng Taro (Birak) Processing to Support Food Security Policy in Central Lombok Regency. Society 13(1): 765-787. doi: 10.33019/society.v13i1.769.

Navia ZI, Suwardi AB, Harmawan T, Syamsuardi, Mukhtar E. 2020. The diversity and contribution of indigenous edible fruit plants to the rural community in the Gayo highlands, Indonesia. Journal of Agriculture and Rural Development in the Tropics and Subtropics 121(1): 89-98. doi: 10.17170/kobra-202004061145.

Nursamsu N, Susantini E, Yuliani Y, Nurhafidhah N. 2025. Diversity and utilization of vegetables and spices by coastal community in East Aceh, Indonesia. Biodiversitas Journal of Biological Diversity 26(2): 837-850. doi: 10.13057/biodiv/d260232.

Ogle BM, Dung NNX, Do TT, Hambraeus L. 2001a. The contribution of wild vegetables to micronutrient intakes among women: An example from the Mekong Delta, Vietnam. Ecology of Food Nutrition 40(2): 159-184. doi: 10.1080/03670244.2001.9991646.

Ogle BM, Johansson M, Tuyet HT, Johannesson L. 2001b. Evaluation of the significance of dietary folate from wild vegetables in Vietnam. Asia Pacific Journal of Clinical Nutrition 10(3): 216-221. doi: 10.1046/j.1440-6047.2001.00261.x.

Olesen RS, Powell B, Kilawe CJ, Rasmussen LV. 2024. Food environment change on wild food consumption in rural Tanzania. Food Security 16(5): 1203-21. doi: 10.1007/s12571-024-01469-6.

Ong HG, Kim Y-D. 2017. The role of wild edible plants in household food security among transitioning hunter-gatherers: evidence from the Philippines. Food Security 9(1): 11-24. doi: 10.1007/s12571-016-0630-6.

Padulosi S, Thompson J, Rudebjer P. Fighting Poverty, Hunger and Malnutrition with Neglected and Underutilized Species (NUS): Needs, Challenges and the Way Forward. Rome: Bioversity International, 2013.

Pawera L, Khomsan A, Zuhud EAM, Hunter D, Ickowitz A, Polesny Z. 2020. Wild food plants and trends in their use: From knowledge and perceptions to drivers of change in West Sumatra, Indonesia. Foods 9(9): 1240. doi: 10.3390/foods9091240.

Penafiel D, Lachat C, Espinel R, Van Damme P, Kolsteren P. 2011. A systematic review on the contributions of edible plant and animal biodiversity to human diets. EcoHealth 8(3): 381-399. doi: 10.1007/s10393-011-0700-3.

Pilling D, Bélanger J. *The state of the world's biodiversity for food and agriculture*. Rome: FAO, 2019.

Pinela J, Carvalho AM, Ferreira ICFR. 2017. Wild edible plants: Nutritional and toxicological characteristics, retrieval strategies and importance for today's society. Food and Chemical Toxicology 110: 165-88. doi: 10.1016/j.fct.2017.10.020.

Powell B, Hall J, Johns T. 2011. Forest cover, use, and dietary intake in the East Usambara Mountains, Tanzania. The International Forestry Review 13(3): 305-317.

Powell B, Thilsted SH, Ickowitz A, Termote C, Sunderland T, Herforth A. 2015. Improving diets with wild and cultivated biodiversity from across the landscape. Food Security 7(3): 535-554. doi: 10.1007/s12571-015-0466-5.

Punchay K, Inta A, Tiansawat P, Balslev H, Wangpakapattanawong P. 2020. Nutrient and mineral compositions of wild leafy vegetables of the Karen and Lawa communities in Thailand. Foods 9(12): 1-15. doi: 10.3390/foods9121748.

Purwayantie S, Suryadi UE. 2020. Plant diversity and nutrient substances of native edible plant: Case study in Suka Maju and Tamao Villages, Kapuas Hulu District, West Kalimantan, Indonesia. Biodiversitas 21(2): 842-852. doi: 10.13057/biodiv/d210252.

Quinlan M. 2005. Considerations for Collecting Freelists in the Field: Examples from Ethobotany. Field Methods 17(3): 219-234. doi: 10.1177/1525822X05277460.

Rahayu YYS. 2024. Examining the potential of wild, underutilized, and neglected edible plants in improving nutrition and wellbeing: A case study in West Java, Indonesia. Paper presented at International Research Meeting of Forest Culture Science Network in East Asia ; 2024 March 16-20 ; Yamanakako, Japan.

Rahayu YYS, Araki T, Rosleine D. 2020. Factors affecting the use of herbal medicines in the universal health coverage system in Indonesia. Journal of Ethnopharmacology 260: e112974. doi: 10.1016/j.jep.2020.112974.

Rahayu YYS, Araki T, Rosleine D, Purwaningtyas RM. 2022. General Practitioners' Attitudes toward Traditional Indonesian Herbal Medicine and Integrative Care in the Universal Health Coverage System. Global Journal of Health Science 14(4): 82. doi: 10.5539/gjhs.v14n4p82.

Rahayu YYS, Sujarwo W, Irsyam ASD, Dwiartama A, Rosleine D. 2024. Exploring unconventional food plants used by local communities in a rural area of West Java, Indonesia : ethnobotanical assessment, use trends, and potential for improved nutrition. Journal of Ethnobiology and Ethnomedicine 20: 68. doi: 10.1186/s13002-024-00710-y.

Rahmat E, Lee J, Kang Y. 2021. Javanese Turmeric (Curcuma xanthorrhiza Roxb.): Ethnobotany, Phytochemistry, Biotechnology, and Pharmacological Activities. Evidence-Based Complementary and Alternative Medicine 2021: 1-15. doi: 10.1155/2021/9960813.

Raneri JE, Boedecker J, Fallas Conejo DA, Muir G, Hanley-Cook G, Lachat C. 2023. Can common dietary assessment methods be better designed to capture the nutritional contribution of neglected, forest, and wild foods to diets? Frontiers in Nutrition 10: 1186707. doi: 10.3389/fnut.2023.1186707.

Reyes-García V, Vadez V, Leonard W, Wilkie D. 2005. Knowledge and Consumption of Wild Plants: A comparative study in two Tsimane villages in the Bolivian Amazon. Ethnobotany Research & Applications 3: 201-208.10.17348/era.3.0.201-208

Roche ML, Creed-Kanashiro HM, Tuesta I, Kuhnlein HV. 2008. Traditional food diversity predicts dietary quality for the Awajún in the Peruvian Amazon. Public Health Nutrition 11(5): 457-465. doi: 10.1017/S1368980007000560.

Rosa CD, Larson LR, Collado S, Profice CC. 2021. Forest therapy can prevent and treat depression: Evidence from meta-analyses. Urban Forestry & Urban Greening 57: 126943. doi: 10.1016/j.ufug.2020.126943.

Roth R. 2004. Spatial Organization of Environmental Knowledge: Conservation Conflicts in the Inhabited Forest of Northern Thailand. Ecology and Society 9(3): art5. doi: 10.5751/ES-01186-090305.

Saensouk P, Saensouk S, Hein KZ, Appamaraka S, Maknoi C, Souladeth P, Koompoot K, Sonthongphithak P, Boonma T, Jitpromma, T. 2025. Diversity, Ethnobotany, and Horticultural Potential of Local Vegetables in Chai Chumphol Temple Community Market, Maha Sarakham Province, Thailand. Horticulturae 11(3): 243. doi: 10.3390/horticulturae11030243.

Sakamoto K, Kaale LD, Ohmori R, Kato T. (eds). 2023a. Changing Dietary Patterns, Indigenous Foods, and Wild Foods. Springer, Singapore. doi: 10.1007/978-981-99-3370-9.

Sakamoto K, Ohmori R, Kaale LD, Mbago FM, Tsuda K, Kato T. 2023b. Does Intake of Wild Foods Improve Subjective Health? Evidence from Three Areas of Tanzania.In: Sakamoto K, Kaale LD, Ohmori R, Kato T. (eds). Changing Dietary Patterns, Indigenous Foods, and Wild Foods. Springer, Singapore, Pp. 199-234.

Selvamani Y, Singh P. 2018. Socioeconomic patterns of underweight and its association with self-rated health, cognition and quality of life among older adults in India. PLOS ONE 13(3): e0193979. doi: 10.1371/journal.pone.0193979.

Septiani N, Hernawati D, Putra RR. 2020. Biodiversity of potentially "lalapan" vegetables in Kampung Adat Naga, Tasikmalaya, Indonesia. Biosfer 13(2): 201-215. doi: 10.21009/biosferjpb.v13n2.201-215.

Setiani S, Setiawan E, Huang W-C. 2022. Taneyan Lanjang Shared Home Gardens and Sustainable Rural Livelihoods of Ethnic Madurese in Madura Island, Indonesia. Sustainability 14(10): 5960. doi: 10.3390/su14105960.

Shin T, Fujikawa K, Moe AZ, Uchiyama H. 2018. Traditional knowledge of wild edible plants with special emphasis on medicinal uses in Southern Shan State, Myanmar. Journal of Ethnobiology and Ethnomedicine 14(1): 1-13. doi: 10.1186/s13002-018-0248-1.

Sibhatu KT, Qaim M. 2018. Review: Meta-analysis of the association between production diversity, diets, and nutrition in smallholder farm households. Food Policy 77: 1-18. doi: 10.1016/j.foodpol.2018.04.013.

Silva HCH, Caraciolo RLF, Marangon LC, Ramos MA, Santos LL, Albuquerque UP. 2014. Evaluating different methods used in ethnobotanical and ecological studies to record plant biodiversity. Journal of Ethnobiology and Ethnomedicine 10(1): 1-11. doi: 10.1186/1746-4269-10-48.

Smith E, Ahmed S, Dupuis V, Running Crane M, Eggers M, Pierre M, Flagg K, Byker Shanks C. 2019. Contribution of Wild Foods to Diet, Food Security, and Cultural Values Amidst Climate Change. Journal of Agriculture, Food Systems, and Community Development 9: 1-24. doi: 10.5304/jafscd.2019.09b.011.

Sujarwo W, Arinasa IBK, Caneva G, Guarrera PM. 2015. Traditional knowledge of wild and semi-wild edible plants used in Bali (Indonesia) to maintain biological and cultural diversity. Plant Biosystems - An International Journal Dealing with all Aspects of Plant Biology 150(5): 971-976. doi: 10.1080/11263504.2014.994577.

Sujarwo W, Rahayu YYS, Sukenti K, Lugrayasa N, Prihardhyanto Keim A, Zuccarello V. 2025. Bio-cultural habits of plant consumption in the food system of traditional Sasak's villages (Indonesia). Ethnobotany Research and Applications 30: 1-15. doi: 10.32859/era.30.22.1-15.

Sukenti K, Hakim L, Indriyani S, Purwanto Y, Matthews PJ. 2016. Ethnobotanical study on local cuisine of the Sasak tribe in Lombok Island, Indonesia. Journal of Ethnic Foods 3(3): 189-200. doi: 10.1016/j.jef.2016.08.002.

Suriadi A, Mulyani A, Hadiawati L, Suratman. 2021. Biophysical characteristics of dry-climate upland and agriculture development challenges in West Nusa Tenggara and East Nusa Tenggara Provinces. IOP Conference Series: Earth and Environmental Science 648(1): 012014. doi: 10.1088/1755-1315/648/1/012014.

Surya R, Tedjakusuma F. 2022. Diversity of sambals, traditional Indonesian chili pastes. Journal of Ethnic Foods 9(1): 25. doi: 10.1186/s42779-022-00142-7.

Susanto T, Syahrul, Sulistyorini L, Rondhianto, Yudisianto A. 2017. Local-food-based complementary feeding for the nutritional status of children ages 6-36 months in rural areas of Indonesia. Korean Journal of Pediatrics 60(10): 320. doi: 10.3345/kjp.2017.60.10.320.

Suwardi AB, Navia ZI, Harmawan T, Mukhtar E, Anderson T. 2020a. Wild edible fruits generate substantial income for local people of the Gunung Leuser National Aceh Tamiang Region. Ethnobotany Research and Applications 20 : 1-13. http://dx.doi.org/10.32859/era.20.11.1-13.

Suwardi AB, Samudra U, Navia ZI, Samudra U, Harmawan T, Syamsuardi, Mukhtar E. 2020b. Ethnobotany and conservation of indigenous edible fruit plants in South Ethnobotany and conservation of indigenous edible fruit plants in South Aceh, Indonesia. Biodiversitas 21(5): 1850-1860. doi: 10.13057/biodiv/d210511.

Suwardi AB, Samudra U, Navia ZI, Samudra U, Harmawan T, Syamsuardi, Mukhtar E. 2022. Importance and local conservation of wild edible fruit plants in the East Aceh Region, Indonesia. International Journal of Conservation Science 13(1): 221-232.

Suwardi AB, Syamsuardi S, Mukhtar E, Nurainas N. 2023. The diversity and traditional knowledge of wild edible fruits in Bengkulu, Indonesia. Ethnobotany Research and Applications 25: 1-17. doi: 10.32859/era.25.15.1-17.

Termote C, Bwama Meyi M, Dhed'a Djailo B, Huybregts L, Lachat C, Kolsteren P, Van Damme P, Hart JP. 2012. A Biodiverse Rich Environment Does Not Contribute to a Better Diet: A Case Study from DR Congo. PLoS ONE 7(1): e30533. doi: 10.1371/journal.pone.0030533.

Timko JA, Waeber PO, Kozak RA. 2010. The socio-economic contribution of non-timber forest products to rural livelihoods in Sub-Saharan Africa: knowledge gaps and new directions. International Forestry Review 12(3): 284-294. doi: 10.1505/ifor.12.3.284.

Umartani LA, Nahdi MS. 2021. Ethnobotany of Community Food Plants on the Slopes of Merapi Merbabu, Central Java, Indonesia. Biology, Medicine, & Natural Product Chemistry 10(1) : 33-39. doi: 10.14421/biomedich.2021.101.33-39

Vajdi M, Farhangi MA. 2020. A systematic review of the association between dietary patterns and health-related quality of life. Health and Quality of Life Outcomes 18(1): 337. doi: 10.1186/s12955-020-01581-z.

Verbowski V, Talukder Z, Hou K, Sok Hoing L, Michaux K, Anderson V, Gibson R, Li KH, Lynd LD, McLean J, Green TJ, Barr SI. 2018. Effect of enhanced homestead food production and aquaculture on dietary intakes of women and children in rural Cambodia: A cluster randomized controlled trial. Maternal & Child Nutrition 14(3): e12581. doi: 10.1111/mcn.12581.

Vijayaragavan V, Sumathi T, Irene Vethamoni P, Ravichandran V, Raju M. 2025. Mechanisms of drought tolerance in Moringa: Strategies for mitigation and adaptation - Review. Plant Science Today 12(1): 1-11. doi: 10.14719/pst.4279.

Walujo EB. 2011. Keanekaragaman hayati untuk pangan. LIPI, Jakarta, Indonesia.

Wang J, Ding X, Guo CA, Zhang X, Feng H, Yang H, Wang Y. 2023. An ethnobotanical study of wild edible plants used by the Tibetan in the Rongjia River Valley, Tibet, China. Journal of Ethnobiology and Ethnomedicine 19: 49. doi: 10.1186/s13002-023-00621-4.

Wang X, Cheng Z. 2020. Cross-Sectional Studies. Chest 158(1): S65-S71. doi: 10.1016/j.chest.2020.03.012.

Wang X, Qi J, Zhang K, Xie H, Wu X. 2024. The joy of eating: how eating experiences enhance the well-being of older adults. Frontiers in Public Health 12: 1438964. doi: 10.3389/fpubh.2024.1438964.

Ware J, Kosinski M, Keller S. 1995. How to Score SF-12 Physical and Mental Health Summary Scales Second Edition. The Health Institute, New England Medical Center, Boston, US.

Wegenast T, Hänze N, Haer R, Birulés M. 2025. The effect of traditional agricultural practices on the food consumption of households facing extreme weather events in Tanzania. Agriculture & Food Security 13(1): 56. doi: 10.1186/s40066-024-00512-1.

Weichart G. 2008. Makan dan minum bersama: feasting commensality in Minahasa, Indonesia. Anthropology of Food S3. doi: 10.4000/aof.2212.

Wicaksana AL, Maharani E, Hertanti NS. 2020. The Indonesian version of the Medical Outcome Survey - Short Form 12 version 2 among patients with cardiovascular diseases. International Journal of Nursing Practice 26(2): 12804. doi: 10.1111/ijn.12804.

Wijaya S. 2019. Indonesian food culture mapping: A starter contribution to promote Indonesian culinary tourism. Journal of Ethnic Foods 6(1): 1-10. doi: 10.1186/s42779-019-0009-3.

Yangdon P, Araki T, Rahayu YYS, Norbu K. 2022. Ethnobotanical study of Wild edible fruits in eastern Bhutan. Journal of Ethnobiology and Ethnomedicine 18: 27. doi: 10.1186/s13002-022-00526-8.

Zereyesus YA, Shanoyan A, Ross KL, Amanor-Boadu V. 2016. The determinants of household-level well-being in Northern Ghana. Development Studies Research 3(1): 1-10. doi: 10.1080/21665095.2016.1229128.

Zhang E, Jiang W, Li W, Ansah EO, Yu X, Wu Y, Xiong F. 2024. Drought Stress Inhibits Starch Accumulation in Taro (Colocasia esculenta L. Schott). Frontiers in Bioscience-Landmark 29(2): 57. doi: 10.31083/j.fbl2902057.

Zhang L, Chai Z, Zhang Y, Geng Y, Wang Y. 2016. Ethnobotanical study of traditional edible plants used by the Naxi people during droughts. Journal of Ethnobiology and Ethnomedicine 12(1): 39. doi: 10.1186/s13002-016-0113-z.

Sachula, Geilebagan, Zhang Y, Zhao H, Khasbagan. 2020. Wild edible plants collected and consumed by the locals in Daqinggou, Inner Mongolia, China. 16 : 60. doi: 10.1186/s13002-020-00411-2.

Zhu Y, Wang Q, Pang G, Lin L, Origasa H, Wang Y, Di J, Shi M, Fan C, Shi H. 2015. Association between Body Mass Index and Health-Related Quality of Life: The “Obesity Paradox” in 21,218 Adults of the Chinese General Population. PLOS ONE 10(6): e0130613. doi: 10.1371/journal.pone.0130613.

Zimmerer KS, de Haan S. 2017. Agrobiodiversity and a Sustainable Food Future. Nature Plants 3: 17047. doi: 10.1038/nplants.2017.47.