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Fruit diversity and rarity in traditional markets of West Java, Indonesia

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Abstract. *Yuwana ALR, Irawan B, Iskandar BS, Iskandar J. 2025. Fruit diversity and rarity in traditional markets of West Java, Indonesia. Biodiversitas 26: 6252-6272.* Traditional markets play a crucial role in biodiversity conservation, particularly for local fruit species and landraces. However, the growing dominance of imported fruits has increasingly threatened the diversity of local fruits, underscoring the need to understand their current status in traditional markets. This study investigated the diversity and rarity of fruit species and landraces sold in three traditional markets: Gedebage, Ujungberung, and Tanjungsari (West Java, Indonesia) and examined traders' knowledge regarding fruit uses and perceived reasons for their rarity. Data were obtained through a census, interviews, and direct observations and analyzed qualitatively and quantitatively using the Relative Frequency of Citation (RFC), Jaccard similarity indices, and Shannon-Wiener diversity indices. A total of 170 fruit entities (including fruit species and distinct landraces) were recorded (including 128 local), represent 59 botanical species from 28 families. Among these, 25 fruits were classified as rare due to unfavourable attributes, limited cultivation, land-use changes, and the influx of commercial commodities. Fruits with the highest RFC value were *Cucumis melo* (0.517), *Carica papaya* "California" (0.482), *Musa acuminata* (0.465), *Citrus x aurantium* "Medan" (0.413), and *Musa x paradisiaca* "Raja Cere", "Ambon Bodas", and "Ambon Lumut" (0.379). The study highlights traditional markets as valuable biodiversity observatories, reflecting the persistence and decline of local fruit diversity in rural agroecosystems. Strengthening their role in biodiversity monitoring and conservation planning can provide an effective, community-based approach to safeguarding local genetic resources.

Keywords: Biodiversity, local fruits, rarity, traditional markets

Abbreviations: LK: Local Knowledge, POWO: Plants of The World Online, RFC: Relative Frequency of Citation, TEK: Traditional Ecological Knowledge

INTRODUCTION

Traditional markets in Indonesia–particularly in West Java and Southeast Asia are important centres for trading food and non-food plants, including fruits, spices, vegetables, carbohydrate sources, and medicinal plants (Zhang et al. 2020; Boonma et al. 2023; Mardiyanto et al. 2023; Santhyami et al. 2024; Marpaung et al. 2025; Tsurayya et al. 2025). These markets support biodiversity conservation by maintaining a wide variety of local fruit species sourced from orchards, rice fields, and home gardens. The relatively flexible quality standards in traditional markets – compared to modern retail - enable the sale of diverse local fruits that might otherwise be excluded for not meeting commercial specifications (Iskandar et al. 2018a, 2020, 2021).

Traditional markets also preserve Traditional Ecological Knowledge (TEK) or Local Knowledge (LK) transmitted orally between traders and buyers (Iskandar et al. 2018a; Nuraeni et al. 2022). Such knowledge guides plant use, classification, and conservation practices, linking biological diversity with cultural identity and sustainability (Franco et al. 2022; Nemogá et al. 2022; Irawan et al. 2024). In West Java, various local fruits and vegetables are still sold in traditional markets, such as black nightshade (*Solanum nigrum* L.), jicama (*Pachyrhizus erosus* (L.) Urb.), and banana (*Musa acuminata* Colla and *M. x paradisiaca* L.) (Iskandar 2018a, b; Susiarti et al. 2021). These species are essential in daily diets and cultural traditions. For instance, bananas are used in rituals, traditional cakes, and fruit salad, while black nightshade is used as a vegetable served with chilli sauce or sauteed (Erawan et al. 2018, 2019; Iskandar et al. 2018b; Mulyanto et al. 2018). Several banana landraces, including *cau ambon, cau raja cere,* and *cau raja bulu,* are locally recognised based on morphology, taste, and specific uses (Iskandar et al. 2018b).

However, biodiversity loss has been occurring in Indonesia and Southeast Asia, especially with many local fruit species disappearing from traditional markets and agroecosystems (Hughes et al. 2017; Iskandar et al. 2018c). In West Java, species such as *Mangifera foetida* Lour.

(horsefruit), *M. kemanga* Blume (*kemang*), and *Antidesma bunius* (L.) Spreng. (*buni*) have become increasingly rare. (Dodo 2015; Pratama et al. 2019; Darsono et al. 2022). The decline is driven by factors such as limited cultivation, weakened cultural attachment, overexploitation, land-use changes, and unfavourable attributes (Iskandar et al. 2018c; Suravanichnirachorn et al. 2018; Susiarti et al. 2020; Penidda et al. 2024; Alfinandah et al. 2025).

While previous ethnobotanical studies have examined general plant diversity in traditional markets, research specifically addressing fruit diversity and rarity, as well as traders' knowledge of local fruits in West Java, remains limited. Few studies have explored how traditional markets can serve as biodiversity monitoring sites, reflecting the persistence or loss of fruit species from surrounding local agroecosystems (Iskandar et al. 2018a, 2021; Santhyami et al. 2024). This study, therefore, aims to document the diversity of the fruit species and landraces traded in several traditional markets in West Java, record traders' knowledge regarding fruit uses and perceived causes of rarity, and identify fruit species and landraces considered rare. By integrating ecological and ethnobiological approaches, this research contributes to understanding the role of traditional markets as sentinel sites for agrobiodiversity conservation, offering a community-based framework for monitoring the decline of local fruit diversity in Indonesia.

MATERIALS AND METHODS

Study area

This research was conducted in June-December 2024 in three traditional markets in West Java Province, Indonesia: Gedebage Market and Ujungberung Market in Bandung City, and Tanjungsari Market in Sumedang District. Gedebage Market is located in Soekarno-Hatta Street, Panyileukan Sub-district (6°55'54.8" S 107°41'51.1" E); Ujungberung Market is on AH Nasution Street, Ujungberung Sub-district (6°54'49.7" S 107°42'08.8" E); and Tanjungsari Market is on Raya Bandung-Cirebon Street, Tanjungsari Sub-district (6°54'27.4" S 107°47'46.4" E) (Figure 1). Gedebage and Ujungberung Markets consisted of both permanent and temporary stalls, while Tanjungsari Market comprised only permanent ones (Figures 2.A-F). All markets operated from early morning to late afternoon (except some stalls that operated 24 hours) and sold various crop commodities, including fruits, vegetables, tubers (*beubeutian*), and spices.

Procedures

A mixed-method approach was used, integrating a preliminary survey, fruit census, structured and semi-structured interviews, and direct observation (Iskandar et al. 2018a, b). The preliminary survey identified optimal data-collection periods, while the census recorded local and imported fruit species and landraces. Structured interviews were conducted with all fruit traders (Gedebage = 85; Ujungberung = 38; Tanjungsari = 28) using a fixed-option questionnaire, and the results were summarized descriptively using percentages to reveal overall patterns and trends.

Semi-structured interviews used a flexible guide of general questions and involved four key informants per market, selected for fruit diversity and >20 years of trading experience. Four informants were chosen to exceed the minimum for triangulation (three), reduce discrepancies, and keep informant numbers consistent across markets to minimize bias. Direct observations were used to validate interview data and record physical traits of fruit species and landraces. Prior to data collection, the researcher obtained permission from market authorities with an official Universitas Padjadjaran research letter, followed institutional ethical guidelines, explained study procedures, and secured verbal informed consent before each interview and census.

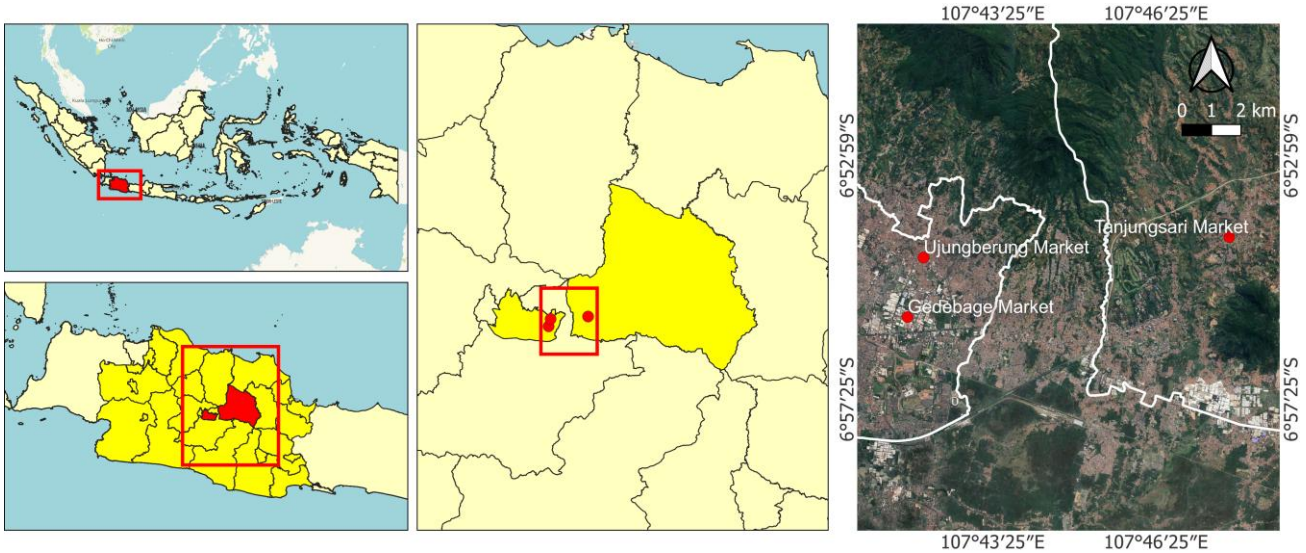

Figure 1. Map of the research locations: Gedebage Market (Bandung City, 6°55'54.8"S 107°41'51.1"E), Ujungberung Market (Bandung City, 6°54'49.7"S 107°42'08.8"E), and Tanjungsari Market (Sumedang District, 6°54'27.4"S 107°47'46.4"E), West Java, Indonesia

Figure 2. Types of traders in the markets in three traditional markets in West Java Province, Indonesia. A. Trader using semipermanent table in Gedebage Market, B. Trader using permanent building in Gedebage Market, C. Trader using permanent building in Tanjungsari Market, D. Trader using permanent building in Ujungberung Market, E. Trader using mat in Ujungberung Market, and F. Trader using motorcycles in Gedebage Market

Data analysis

Qualitative data analysis

Qualitative data analysis was carried out in several stages: cross-checking interview results, summarizing the data, synthesizing the data to draw comprehensive conclusions, describing the data, and narrating the results (Irawan et al. 2024). Data cross-checking was conducted through triangulation by comparing responses among informants and with secondary sources. Fruit species and families were identified using the POWO database (https://powo.science.kew.org/), while the characteristics of fruit landraces were identified through book and journal references. The rarity status of fruit (rare/not rare) was determined based on traders' perception and then cross-checked ethically with several references, namely Agus et al. (2014), Dodo (2015), Husodo et al. (2018), Pratama et al. (2019), Anggraeni et al. (2023), and Rahayu et al. (2024).

Quantitative data analysis

Quantitative data analysis was conducted using several formulas: RFC, the percentage of local and imported fruit species sold in the markets, the Jaccard Similarity Index, and the Shannon-Wiener Index. The RFC was calculated using the following formula (Pradhan et al. 2020; Hou et al. 2024; Irawan et al. 2024).

$$RFC = \frac{FC}{N} \text{ x } 100\%$$

Where: RFC: Relative frequency citation, FC: The number of respondents citing a specific fruit species/landrace, N: The total number of respondents

RFC analysis was used to compare the proportion of respondents citing a particular species/landrace against the total respondents. A higher RFC value indicates that the species or landrace was more frequently cited, suggesting that it is relatively common, whereas a lower RFC value indicates less frequent citation, suggesting relative rarity.

Jaccard Similarity Index

The Jaccard Similarity Index was calculated using the following formula (Faruque et al. 2019; Merrouni et al. 2021; Iskandar et al. 2022):

$$Ji = \frac{C}{A+B-C} \text{ x } 100$$

Where: Ji: Jaccard Similarity Index, A: Number of fruit species sold in the first market, B: Number of fruit species sold in the second market, C: Number of fruit species sold in both markets

The index was applied to compare the similarity of fruit species in the markets of Gedebage, Ujungberung, and Tanjungsari. A higher similarity index indicates that the two markets being compared share many fruits in common, whereas a lower value indicates fewer shared species.

Comparison of local and imported fruit species

The comparison between local and imported fruit species was calculated using proportions and percentages modified from Huang et al. (2016) and Thakur et al. (2020). The proportion represents the ratio of the number of local or imported fruit species to the total number of fruit species sold in the markets. As a ratio, the proportion value is less than 1, and when multiplied by 1, it yields the percentage. Both proportions and percentages are useful because they allow for straightforward ranking and comparison of fruit categories.

$$A = \frac{C}{E} \text{ x } 100\%$$

$$B = \frac{D}{E} \text{ x } 100\%$$

Where A: Percentage of local fruit species sold in the markets, B:Percentage of imported fruit species sold in the markets, C:Number of local fruit species, D: Number of imported fruit species, E: Total number of fruit species sold in the markets

Shannon-Wiener Index

The Shannon-Wiener Index was used to evaluate the diversity of fruit species in Gedebage, Ujungberung, and Tanjungsari Markets. The Shannon-Wiener Index in each market was calculated and classified using the following formula (Amarullah et al. 2017; Yuningsih et al. 2021):

$$H' = - \Sigma (ni/N) \ln (ni/N)$$

Where: ni: The total number of individuals belonging to a particular fruit species, ln = Natural logarithm (ln), N: The total number of individuals from all fruit species.

H'< 1.00: Fruit diversity is low, stress is high, and the ecosystem is unstable, 1 < H' < 3.322: Fruit diversity is medium, enough ecosystem balance, medium ecological stress, H ≥ 3.322: Fruit diversity is high, ecosystem stability is steady, and it resists ecological stress

RESULTS AND DISCUSSION

Traders' perception of fruits and local fruits

Based on traders' perception, two main aspects are used to define crop plants: their relative position to the ground and their use as food ingredients. In general, traders consider fruits as plants that grow above the ground or hang on trees, such as watermelon/*samangka* (*Citrullus lanatus* L.) and banana/*cau* (*M. x paradisiaca*). Plants that grow underground are referred to as *beubeutian* (tuber in botanical classification), which includes cassava/*sampeu* (*Manihot esculenta* Crantz), taro/*taleus* (*Colocasia esculenta* (L.) Schott), and sweet potato/*hui* (*Ipomoea batatas* (L.) Lam.). Based on their use as food ingredients, some traders distinguish crop plants as fruits and vegetables. In this context, fruits are defined as plants consumed for desserts, either eaten directly, simply processed (fried/boiled), or made into other products such as cakes, juices, and *rujak* (fruit salads). Examples include banana and ambarella (*Spondias dulcis* Parkinson). Vegetables, on the other hand, are plants that generally need to be cooked first or serve as main ingredients of dishes, such as tomato (*Solanum lycopersicum* L.) and eggplant (*Solanum melongena* L.).

Because traders perceive two different criteria for defining fruits, some plants are classified in overlapping categories. Most traders regard jicama (*P. erosus*) as *beubeutian* because it grows underground, but others classify it as a fruit since it can be made into *rujak.* Similarly, most traders consider the tomato a vegetable because it is cooked and served as a main ingredient in Sundanese cuisine.

Based on their origin, traders categorized fruits into local and imported types. Local fruits are those supplied within West Java or other regions in Indonesia. Examples include horsefruit (*M. foetida*), sourced from Cikampek, and Cavendish banana (*M. acuminata*). Imported fruits are those supplied from outside Indonesia, such as pear (*Pyrus communis* L.) from Vietnam and date (*Phoenix dactylifera* L.) sourced from Egypt and Tunisia. Some fruits are supplied from both inside and outside Indonesia, such as apples (*Malus domestica* (Suckow) Borkh.), which are supplied from Malang (East Java, Indonesia), New Zealand, and China.

Knowledge of classifying food plants, as reported by traders, is part of a larger regional tendency. Previous ethnobotanical studies conducted in other regions in Indonesia and Southeast Asia (Lucius et al. 2021; Sulistiyowati et al. 2022; Adinugraha et al. 2024; Saensouk et al. 2025b), supported by the scientific studies on the classification of food plants based on their organs and origins (Iketani 2016; Offringa et al. 2019; FAO and CIRAD 2021; Zierer et al. 2021), have documented similar findings, namely how local communities maintain distinct knowledge based on their perception and experience in classifying food plants into several specific categories.

Lucius et al. (2021) and Adinugraha et al. (2024) stated that, based on their position relative to the ground, Javanese people in Central Java classify food plants (*pala*) into three categories: *pala kesampar* (fruits or vegetables that grow on the ground surface, e.g., cucumber/*Cucumis sativus* L.), *pala gumatung* (fruit hanging on the trees, e.g., mango/ *Mangifera indica* L.), and *pala kependhem* (underground tubers, e.g., arrowroot/*Maranta arundinacea* L. and taro/*C. esculenta*). Sulistiyowati et al. (2022) also reported that local communities in Yogyakarta recognize *jangan*, referring to plants consumed as vegetables prepared with broth from coconut milk. Some of these plants are botanically classified as fruits, including chili (*Capsicum annuum* L.) and wax gourd (*Benincasa hispida* (Thunb.) Cogn.). Similarly, Saensouk et al. (2025b) found that in northern Thailand, people use young pumpkin fruits (*Cucurbita moschata* Duchesne) as vegetables. Then, *Solanum americanum* Mill. serves a dual purpose in local foods - eaten fresh as fruit and cooked as a vegetable.

The classification of food crops into fruits, vegetables, and tubers in this study, as well as in previous research, aligns with the etic perspective. Two conceptual boundaries are commonly used to differentiate these food crop categories. From a botanical point of view, fruits are fully grown ovaries of plants that have been pollinated. They may or may not have seeds inside. In contrast, in culinary terms, fruits are plant organs that taste sweet and sour and are typically consumed as snacks or desserts. Vegetables, from a culinary perspective, refer to any plant parts (fruit, leaves, shoots, etc.) that tend to have a bland taste. (Offringa et al. 2019; FAO and CIRAD 2021). Tubers are enlarged plant organs (roots or stems) that function as storage organs for nutrients and are located underground (Offringa et al. 2019; Zierer et al. 2021).

Iketani (2016) defined local fruits as those that have been cultivated in a particular region for a long time (approximately 100-200 years), whether native to the area or introduced. It can be inferred that traders' definitions of local fruit generally align with the literature; however, traders distinguish two geographical scales of "local" - one limited specifically to West Java, and the other encompassing Indonesia as a whole.

Diversity of fruit species and landraces sold

A total of 170 types of fruits were sold in the three markets, according to traders' knowledge. These 170 types were classified into 59 species and 28 families based on botanical classification. The highest diversity of fruit species and landraces was found in Gedebage Market. (Tables 1 and 2). The greater number of fruit species and landraces sold in Gedebage Market is due to the fact that Gedebage Market is a wholesale market, with a larger scale of service activities compared to Ujungberung and Tanjungsari Markets, which are categorized as retail markets. In addition, Gedebage Market is located near Gedebage Terminal, which makes it easier for fruit supplies from various regions to be delivered. This is evident from the diverse origins of the fruit stocked in the market, both from inside West Java and outside West Java, including *mangga arumanis* (*M. indica*) supplied from Indramayu and *salak pondoh* (*Salacca zalacca* (Gaertn.) Voss) from Yogyakarta. Although fruit supplies in the other two markets also come from various regions, the diversity of supply origins at Gedebage Market is more varied. These research data are consistent with Scavuzzo et al. (2024), which stated that wholesale markets function as aggregators of commodities to be sold from diverse sources and serve as connectors between producers (suppliers) and retail markets, while also continuing to accommodate small-scale purchasing activities.

Local fruit species remain dominant in the Gedebage, Ujungberung, and Tanjungsari Markets (Figure 3). This is because local fruits are still used by the communities living around these markets for various purposes, including as food sources, medicine, and for traditional rituals (Table 3). The dominance of local species sold, as reported in this study, is also observed in various regions across the world, including Bolivia, Tanzania, and Turkey (Bussmann et al. 2016; Hilonga et al. 2019; Uzun and Koca 2020). However, this contrasts with the findings of Franco et al. (2020) in Brunei Darussalam, where local commodities are dominated by non-local ones. This reflects that local communities in many parts of the world, including Indonesia, still tend to make use of local commodities to meet their daily needs. Nevertheless, this study found indications of biodiversity loss, as several local fruit species were considered rare according to traders' perception, including *A. bunius* (bignay), and *Syzygium cumini* (L.) Skeels (Java plum). Furthermore, although local fruit species are still dominated overall, the percentage of local fruit species in Gedebage Market is lower than two other markets. This may be because Gedebage Market is geographically closer to Jakarta than Ujungberung and Tanjungsari Markets. Jakarta, in turn, is home to Tanjung Priok Port, a major entry point of imported fruits.

Observations showed high Jaccard Similarity among markets (0.75-0.8448) and high Shannon–Wiener Diversity Index within each market (3.344-3.485) (Tables 4 and 5), indicating that fruit diversity is high but largely similar across the three markets. This suggests a limited role in conserving unique (rare) fruit species, mainly because fruit supplies come from similar sources (e.g., many fruits in Gedebage from Caringin Wholesale Market, and Ujungberung and Tanjungsari also supplied from Caringin and Gedebage) and because traders and consumers prefer familiar commercial fruits. Stall inventories showed most traders sold common fruits (papaya, melon, banana), while rarer species such as *A. bunius* and *S. cumini* appeared in only one or two stalls, influenced by less favorable attributes and land-use change. This pattern aligns with studies in Indonesia and Malaysia showing preference for commercial fruits and declining local species due to disinterest and loss of traditional knowledge, especially among younger generations. Overall, traditional markets act as key distribution channels from farmers to consumers and as practical monitoring sites for local fruit biodiversity: the presence of a species in the market signals it is still cultivated, traded, and valued, and absence suggests the opposite.

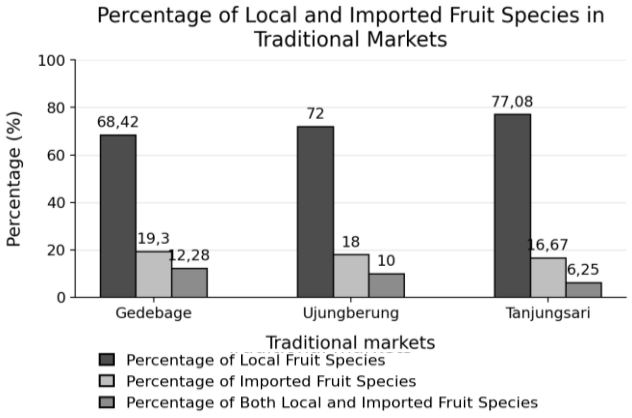

Figure 3. Percentage of local and imported fruits traded in traditional markets of West Java, Indonesia

Table 1. Species and landraces of local, imported, and rarety of fruits traded in three traditional markets of West Java, Indonesia

Market	Local fruit species (including landraces)	Imported fruit species (including landraces)	Local and imported fruit species (including landraces)	Total fruit species (including landraces)	Total local rare fruit species and landraces based of emic perspective (%)
Gedebage	112	37	1	150	25 (19.53%)
Ujungberung	83	25	1	109	
Tanjungsari	85	15	2	102	
Total	128	40	2	170	

Table 2. Fruit diversity, origin, and RFC value in Gedebage Market, Ujungberung Market, and Tanjungsari in West Java, Indonesia

Species	Family	Vernacular name	English name	RFC value		
				GB	UB	TS
Actinidia chinensis var. *deliciosa* (A.Chev.) A.Chev.	Actinidiaceae	*Kiwi*	Kiwifruit	0.024	0.027	-
Mangifera foetida Lour.	Anacardiaceae	*Limus*	Horsefruit	0.035	0.079	0.034
Mangifera indica L.	Anacardiaceae	*Mangga arumanis*	Mango	0,082	0.079	0.345
Mangifera indica L.	Anacardiaceae	*Mangga arumanis bali*	Mango	0.082	0.079	-
Mangifera indica L.	Anacardiaceae	*Mangga gedong*	Mango	0.094	0.105	0.103
Mangifera indica L.	Anacardiaceae	*Mangga gedong gincu*	Mango	0.047	0.105	0.103
Mangifera indica L.	Anacardiaceae	*Mangga cengkir*	Mango	0.282	0.184	0.103
Mangifera indica L.	Anacardiaceae	*Mangga manalagi*	Mango	0.035	0.077	-
Mangifera indica L.	Anacardiaceae	*Mangga budiraja*	Mango	0.024	0.027	-
Mangifera indica L.	Anacardiaceae	*Mangga alpukat*	Mango	0.106	0.027	-
Mangifera indica L.*	Anacardiaceae	*Mangga red emperor*	Mango	0.012	-	-
Mangifera indica L.	Anacardiaceae	*Mangga golek*	Mango	0.047	0.052	0.034
Mangifera indica L.	Anacardiaceae	*Mangga golek lanang*	Mango	0.024	-	-
Mangifera indica L.	Anacardiaceae	*Mangga kopyor*	Mango	0.012	-	-
Mangifera indica L.	Anacardiaceae	*Mangga kidang*	Mango	0.012	-	-
Mangifera indica L.	Anacardiaceae	*Mangga gadung/TO*	Mango	0.012	-	-
Mangifera indica L.	Anacardiaceae	*Mangga mawar*	Mango	0.012	-	-
Mangifera indica L.	Anacardiaceae	*Mangga benhur*	Mango	-	0.027	-
Mangifera odorata Griff.	Anacardiaceae	*Kweni*	Fragrant Mango	0.106	0.131	0.034
Spondias dulcis Parkinson	Anacardiaceae	*Kedondong*	Golden Apple	0.047	0.105	0.206
Annona squamosa L.	Annonaceae	*Srikaya*	Sugar Apple	-	0.027	-
Annona muricata L.	Annonaceae	*Sirsak*	Soursop	0.059	-	0.068
Salacca zalacca (Gaertn) Voss	Arecaceae	*Salak pondoh*	Snakefruit	0.094	0.079	0.068
Salacca zalacca (Gaertn) Voss	Arecaceae	*Salak lokal*	Snakefruit	0.024	-	-
Cocos nucifera L.	Arecaceae	*Kalapa*	Coconut	0.082	0.079	0.310
Phoenix dactylifera L.*	Arecaceae	*Korma ajwa*	Dates	0.035	-	-
Phoenix dactylifera L.*	Arecaceae	*Korma barhi*	Dates	0.024	-	-
Phoenix dactylifera L.*	Arecaceae	*Korma sukary*	Dates	0.024	-	-
Phoenix dactylifera L.*	Arecaceae	*Korma golden valley*	Dates	0.035	-	0.034
Ananas comosus L.	Bromeliaceae	*Nanas madu*	Pineapple	0.047	0.105	0.068
Ananas comosus L.	Bromeliaceae	*Nanas subang*	Pineapple	0.082	0.158	0.265
Ananas comosus L.	Bromeliaceae	*Nanas bogor*	Pineapple	0.012	0.079	0.103
Ananas comosus L.	Bromeliaceae	*Nanas palembang*	Pineapple	0.012	0.053	-
Ananas comosus L.	Bromeliaceae	*Nanas kediri*	Pineapple	0.035	0.027	0.206
Selenicereus undatus (Haw) D.R Hunt	Cactaceae	*Buah Naga*	Dragonfruit	0.259	0.263	0.379
Carica papaya L.	Caricaceae	*Gedang california*	Papaya	0.189	0.316	0.482
Carica papaya L.	Caricaceae	*Gedang calina*	Papaya	0.024	-	-
Carica papaya L.	Caricaceae	*Gedang thailand*	Papaya	0.059	-	0.034
Garcinia mangostana L.	Clusciaceae	*Manggis*	Mangosteen	0.012	-	0.034
Citrullus lanatus L.	Cucurbitaceae	*Samangka dragon*	Watermelon	0.082	0.105	0.068
Citrullus lanatus L.	Cucurbitaceae	*Samangka baby/inul*	Watermelon	0.106	0.079	0.103
Citrullus lanatus L.	Cucurbitaceae	*Samangka nonbiji*	Watermelon	0.153	0.131	0.206
Citrullus lanatus L.	Cucurbitaceae	*Samangka golden*	Watermelon	0.035	-	0.034
Cucumis melo L.	Cucurbitaceae	*Melon*	Melon	0.129	0.184	0.517
Cucumis melo L.	Cucurbitaceae	*Bonteng suri, blewah*	Cantaloupe	0.059	0.079	0.068
Cucurbita moschata Duchesne	Cucurbitaceae	*Waluh koneng*	Butternut squash	0.047	0.105	0.068
Lagenaria siceraria (Molina) Standl.	Cucurbitaceae	*Kukuk*	Bottle gourd	0.024	-	-
Diospyros kaki Thunb.	Ebenaceae	*Kesemek*	Persimmon	0.118	0.079	0.034
Pachyrhizus erosus (L.) Urb.	Fabaceae	*Bengkuang*	Yam	0.071	0.211	0.276
Pachyrhizus erosus (L.) Urb.	Fabaceae	*Bengkuang padalarang*	Yam	0.012	-	-
Pachyrhizus erosus (L.) Urb.	Fabaceae	*Bengkuang garut*	Yam	0.012	-	-
Pachyrhizus erosus (L.) Urb.	Fabaceae	*Bengkuang lampung*	Yam	0.012	-	-
Punica granatum L.**	Lythraceae	*Delima*	Pommegranate	0.024	0.027	0.034
Persea americana L.	Lauraceae	*Alpukat markus*	Avocado	0.024	-	-
Persea americana L	Lauraceae	*Alpukat aligator*	Avocado	0.024	-	0.034
Persea americana L.	Lauraceae	*Alpukat mentega*	Avocado	0.035	0.052	0.172
Persea americana L.	Lauraceae	*Alpukat susu*	Avocado	0.012	0.079	0.034
Persea americana L.	Lauraceae	*Alpukat minyak*	Avocado	-	0.052	0.034
Persea americana L.	Lauraceae	*Alpukat lokal*	Avocado	-	-	0.068
Persea americana L.	Lauraceae	*Alpukat miki*	Avocado	-	-	0.034
Durio zibethinus L.	Malvaceae	*Kadu lokal*	Durian	0.012	0.027	-
Durio zibethinus L.*	Malvaceae	*Kadu montong*	Durian	0.012	0.027	-

Species	Family	Vernacular name	English name	RFC value		
				GB	UB	TS
Durio zibethinus L.	Malvaceae	*Kadu musang king*	Durian	0.012	-	-
Durio zibethinus L.	Malvaceae	*Kadu petruk*	Durian	-	0.027	-
Durio zibethinus L.	Malvaceae	*Kadu bawor*	Durian	0.012	-	-
Durio zibethinus L.	Malvaceae	*Kadu hejo*	Durian	-	0.027	-
Durio zibethinus L.	Malvaceae	*Kadu sumatra*	Durian	-	0.027	-
Lansium domesticum Correa	Meliaceae	*Dukuh*	Langsat	0.071	0.027	0.034
Lansium domesticum Correa	Meliaceae	*Dukuh ciamis*	Langsat	-	0.027	-
Lansium domesticum Correa	Meliaceae	*Dukuh palembang*	Langsat	-	0.027	
Lansium domesticum Correa	Meliaceae	*Langsat*	Langsat	0.012	-	-
Lansium domesticum Correa	Meliaceae	*Pisitan*	Langsat	0.012	-	0.034
Lansium domesticum Correa	Meliaceae	*Kokosan*	Langsat	0.012	-	-
Artocarpus heterophyllus Lam.	Moraceae	*Nangka*	Jackfruit	0.035	0.027	0.068
Musa acuminata Colla (genomic group AAA) [d, f]	Musaceae	*Cau cavendish*	Cavendish Banana	0.035	0.052	-
Musa acuminata Colla (genomic group AA) [d, e]	Musaceae	*Cau muli*	Banana	0.165	0.105	0.465
Musa acuminata Colla (genomic group AA) [d]	Musaceae	*Cau bangkahulu*	Banana	0.106	0.105	0.103
Musa acuminata Colla (genomic group AA) [d]	Musaceae	*Cau ketan/jantan*	Banana	0.047	-	-
Musa acuminata subsp. *acuminata* Colla (genomic group AA) [f]	Musaceae	*Cau hurang*	Blood banana	0.024	0.027	0.034
Musa acuminata Colla (genomic group AAA) [c]	Musaceae	*Cau angleng*	Banana	0.024	-	0.034
Musa acuminata Colla (genomic group AA) [d]	Musaceae	*Cau barangan*	Lakatan banana	0.035	-	-
Musa acuminata Colla (genomic group AA) [d]	Musaceae	*Cau mas/cau kirana*	Banana	0.035	0.027	0.034
Musa acuminata Colla (genomic group AAA) [d]	Musaceae	*Cau kapas*	Banana	0.071	0.052	0.172
Musa balbisiana Colla (genomic group BBB) [c]	Musaceae	*Cau manggala*	Plantain banana	0.035	-	-
Musa balbisiana Colla (genomic group BBB) [e]	Musaceae	*Cau galeng*	Plantain banana	-	-	0,034
Musa x paradisiaca L. (genomic group AAB) [d]	Musaceae	*Cau tanduk biasa*	Horn plantain	0.106	0.237	0.103
Musa x paradisiaca L. (genomic group AAB) [d]	Musaceae	*Cau tanduk sukabumi*	Horn plantain	0.035	0.027	-
Musa x paradisiaca L. (genomic group AAB) [d]	Musaceae	*Cau tanduk kompan*	Horn plantain	0.082	0.077	0.172
Musa x paradisiaca L. (genomic group AAB) [d]	Musaceae	*Cau nangka*	Banana	0.118	0.052	0.310
Musa x paradisiaca L.(genomic group AAB) [c]	Musaceae	*Cau bogo*	Banana	0.012	-	-
Musa x paradisiaca L.(genomic group AAB) [c]	Musaceae	*Cau raja bulu*	Raja banana	0.118	0.105	0.206
Musa x paradisiaca L.(genomic group AAB) [c]	Musaceae	*Cau susu*	Banana	0.012	-	-
Musa x paradisiaca L.(genomic group AAB) [a]	Musaceae	*Cau lampeneng*	Banana	0.047	0.027	0.034
Musa x paradisiaca L. (genomic group AAAB) [d]	Musaceae	*Cau kastroli*	Banana	0.035	0.052	0.034
Musa x paradisiaca L. (genomic group AAB) [c]	Musaceae	*Cau raja cere*	Silk banana	0.106	0.077	0.379
Musa x paradisiaca L. (genomic group ABB) [e]	Musaceae	*Cau kepok saba*	Saba banana	0.118	0.105	0.068
Musa x *paradisiaca* L. (genomic group ABB) [e]	Musaceae	*Cau kepok jablay*	Saba banana	0.106	0.105	0.068
Musa x paradisiaca L. (genomic group ABB) [d]	Musaceae	*Cau siem paris*	Banana	0.106	-	0.034
Musa x paradisiaca L. (genomic group ABB) [d]	Musaceae	*Cau siem jimluk*	Banana	0.106	-	0.034
Musa x paradisiaca L. (genomic group ABB) [d]	Musaceae	*Cau siem*	Banana	0.071	0.027	0.068
Musa x paradisiaca L. (genomic group ABB) [b]	Musaceae	*Cau bawen/pisang usuk*	Banana	0.047	-	0.034
Musa x paradisiaca L. (genomic group ABB) [e]	Musaceae	*Cau ampeang*	Banana	0.035	-	0.034

Species	Family	Vernacular name	English name	RFC value		
				GB	UB	TS
Musa x paradisiaca L. (genomic group AAA) [d]	Musaceae	*Cau ambon lumut biasa*	Banana	0.165	0.077	0.379
Musa x paradisiaca L. (genomic group AAA) [d]	Musaceae	*Cau ambon lumut lembang*	Banana	-	0.052	-
Musa x paradisiaca L. (genomic group AAA) [d]	Musaceae	*Cau ambon lumut palintang*	Banana	-	0.105	-
Musa x paradisiaca L. (genomic group AAA) [d]	Musaceae	*Cau ambon bodas*	Banana	0.129	0.105	0.379
Musa sp1.	Musaceae	*Cau geulis*	Banana	0.012	0.027	0.034
Musa sp2.	Musaceae	*Cau roid*	Banana	-	-	0.068
Psidium guajava L.	Myrtaceae	*Jambu biji*	Guava	0.035	0.027	0.172
Psidium guajava L. **	Myrtaceae	*Jambu kristal*	Guava	0.071	0.027	0.103
Syzygium samarangense (Blume) Merr. & L.M.Perry	Myrtaceae	*Jambu citra*	Java apple	0.024	0.027	0.168
Syzygium cumini (L.) Skeels	Myrtaceae	*Jamblang*	Java plum	0.012	0.027	-
Syzygium aqueum (Burm.f.) Alston	Myrtaceae	*Jambu air*	Water apple	0.047	0.131	0.206
Syzygium aqueum (Burm.f.) Alston	Myrtaceae	*Jambu air cincalo*	Water apple	-	-	0.034
Syzygium aqueum (Burm.f.) Alston	Myrtaceae	*Jambu air kancing*	Water apple	-	-	0.034
Syzygium polycephalum (Miq.) Merr & L.M.Perry	Myrtaceae	*Kupa*	Gowok	0.012	0.027	-
Averrhoa carambola L.	Oxalidaceae	*Balingbing*	Starfruit	0.094	0.078	0.276
Passiflora edulis Sims	Passifloraceae	*Markisa*	Passionfruit	0.012	-	-
Passiflora ligularis Juss.	Passifloraceae	*Konyal*	Sweet granadilla	0.035	0.052	0.034
Antidesma bunius (L.) Spreng.	Phyllanthaceae	*Buni, huni*	Bignay	0.012	0.052	-
Baccaurea racemosa (Reinw) Mull.Arg.	Phyllanthaceae	*Menteng*	Menteng	0.035	0.052	0.034
Phyllanthus acidus (L.) Skeels	Phyllanthaceae	*Ceremai*	Star gooseberry	0.012	0.052	
Fragaria vesca L.	Rosaceae	*Stroberi*	Strawberry	0.047	0.027	0.068
Malus domestica (Suckow) Borkh. *	Rosaceae	*Apel fuji*	Apple	0.129	0.184	0.345
Malus domestica (Suckow) Borkh.*	Rosaceae	*Apel merah*	Apple	0.024	-	0.034
Malus domestica (Suckow) Borkh.	Rosaceae	*Apel malang*	Apple	0.094	0.027	0.034
Malus domestica (Suckow) Borkh.	Rosaceae	*Apel manalagi*	Apple	0.035	0.027	0.034
Malus domestica (Suckow) Borkh.*	Rosaceae	*Apel granny smith*	Apple	0.059	0.052	0.068
Malus domestica (Suckow) Borkh.*	Rosaceae	*Apel royal gala*	Apple	0.059	0.105	-
Prunus domestica L.*	Rosaceae	*Plum*	Plum	0.012	-	-
Pyrus pyrifolia (Burm.f.) Nakai *	Rosaceae	*Pir singo*	Asian Pear	0.024	0.079	-
Pyrus pyrifolia (Burm.f.) Nakai *	Rosaceae	*Pir century*	Asian Pear	0.141	0.131	0.103
Pyrus bretschneideri Rehder *	Rosaceae	*Pir yali*	Chinese white pear	0.094	0.141	0.205
Pyrus bretschneideri Rehder *	Rosaceae	*Pir xiang lie*	Chinese white pear	0.024	0.027	-
Pyrus communis L.*	Rosaceae	*Pir packham / pir jambu*	European pear	0.071	0.027	0.034
Pyrus communis L.*	Rosaceae	*Pir forelle*	European pear	0.024	0.027	-
Citrus x limon (L.) Osbeck	Rutaceae	*Lemon lokal*	Lemon	0.071	-	0.034
Citrus x limon (L.) Osbeck *	Rutaceae	*Lemon impor*	Lemon	0.047	0.027	-
Citrus maxima (Burm) Merr.	Rutaceae	*Jeruk bali*	Pomelo	0.012	0.027	0.034
Citrus x aurantium f. *aurantium* L.	Rutaceae	*Jeruk medan*	Bitter orange	0.212	0.131	0.413
Citrus x aurantium f. *aurantium* L.	Rutaceae	*Jeruk peres*	Bitter orange	0.071	0.027	0.068
Citrus x aurantium f. *aurantium* L.	Rutaceae	*Jeruk jember*	Bitter orange	0.035	-	-
Citrus x aurantium f. *aurantium* L.	Rutaceae	*Jeruk pontianak*	Bitter orange	0.024	0.027	0.068
Citrus x aurantium f. *aurantium* L. *	Rutaceae	*Jeruk sunkist maple*	Bitter orange	0.082	0.027	-
Citrus x aurantium f. *aurantium* L.*	Rutaceae	*Jeruk sunkist valencia*	Bitter orange	0.082	0.027	-
Citrus x aurantium f. *deliciosa* (Ten) M.Hiroe	Rutaceae	*Jeruk garut*	Mandarin orange	0.012	-	-
Citrus reticulata Blanco *	Rutaceae	*Jeruk wogan*	Mandarin orange	0.047	0.027	-
Citrus reticulata Blanco *	Rutaceae	*Jeruk wokam*	Mandarin orange	0.047	0.027	-
Citrus reticulata Blanco.*	Rutaceae	*Jeruk santang biasa*	Mandaein orange	0.035	-	-
Citrus reticulata Blanco *	Rutaceae	*Jeruk santang birma*	Mandarin orange	0.012	-	-
Citrus reticulata Blanco *	Rutaceae	*Jeruk santang tangerine*	Mandarin orange	0.012	-	-
Citrus reticulata Blanco *	Rutaceae	*Jeruk santang daun*	Mandarin orange	-	0.027	0.137
Citrus reticulata Blanco *	Rutaceae	*Jeruk santang gundul*	Mandarin orange	-	0.027	0.034
Citrus reticulata Blanco	Rutaceae	*Jeruk ragi*	Mandarin orange	0.012	-	-
Citrus reticulata Blanco *	Rutaceae	*Jeruk kino*	Mandarin orange	0.035	-	-
Citrus reticulata Blanco *	Rutaceae	*Jeruk santang madu*	Mandarin orange	-	0.027	0.034
Triphasia trifolia (Burm.f.) P.Wilson *	Rutaceae	*Jeruk kinkit*	Limeberry	0.012	-	-
Dimocarpus longan Lour. *	Sapindaceae	*Lengkeng*	Longan	0.071	0.105	0.241

Species	Family	Vernacular name	English name	RFC value		
				GB	UB	TS
Litchi chinensis Sonn. *	Sapindaceae	*Leci*	Lychee	0.024	0.027	0.034
Nephelium lappaceum L.	Sapindaceae	*Rambutan*	Rambutan	0.035	0.131	0.034
Pometia pinnata JR.Forst & G.Forst.	Sapindaceae	*Matoa*	Matoa	0.024	-	-
Manilkara zapota (L.) P.Royen	Sapotaceae	*Sawo*	Sapodilla	0.035	0.027	0.103
Lucuma campechiana Kunth	Sapotaceae	*Campolay*	Canistel	-	0.027	0.068
Solanum lycopersicum L.	Solanaceae	*Tomat*	Tomato	0.012	0.052	0.034
Vitis vinifera L.*	Vitaceae	*Anggur red globe*	Grape	0.106	0.131	0.294
Vitis vinifera L.*	Vitaceae	*Anggur muscat*	Grape	0.071	0.079	0.206
Vitis vinifera L.*	Vitaceae	*Anggur black autum*	Grape	0.059	0.027	0.034
Vitis vinifera L.*	Vitaceae	*Anggur jari*	Grape	0.027	-	-
Vitis vinifera L.*	Vitaceae	*Anggur crimson*	Grape	0.035	-	-
Vitis vinifera L.*	Vitaceae	*Anggur thomson*	Grape	0.024	-	-

Notes: GB: Gedebage, UB: Ujungberung, TS: Tanjungsari. "-": Not traded in the market, "*": Imported, "**": Both local and imported. The grouping of bananas into specific genomic groups in this table is based on several references, which indicated by superscript numbers, namely a: Ministry of Agriculture of The Republic of Indonesia (2014), b: Hapsari et al. (2015), c: Iskandar et al. (2018b), d: Poerba et al. (2018), e: Erawan et al. (2019), and f: Igwe et al. (2021)

Table 3. The status of fruit rarity based on emic and etic perspective

Species	Family	Vernacular name	Rarity status (emic)	Rarity status (ethic)
Mangifera foetida Lour.	Anacardiaceae	*Limus*	Rare	Rare
Mangifera indica L	Anacardiaceae	*Mangga golek*	Not rare	Rare
Mangifera indica L	Anacardiaceae	*Mangga golek lanang*	Rare	Not rare
Mangifera indica L.	Anacardiaceae	*Mangga kidang*	Rare	Not rare
Mangifera odorata Griff.	Anacardiaceae	*Kaweni*	Not rare	Rare
Spondias dulcis Parkinson	Anacardiaceae	*Kedondong*	Rare	Rare
Annona squamosa L.	Annonaceae	*Srikaya*	Rare	Rare
Salacca zalacca (Gaertn.) Voss	Araceae	*Salak lokal*	Rare	Not rare
Carica papaya L.	Caricaceae	*Gedang thailand*	Rare	Not rare
Lagenaria siceraria (Molina) Standl.	Cucurbitaceae	*Kukuk*	Not rare	Rare
Diospyros kaki Thunb.	Ebenaceae	*Kesemek*	Rare	Not rare
Punica granatum L.	Lyhtraceae	*Delima*	Rare	Rare
Lansium domesticum Correa	Meliaceae	*Pisitan*	Rare	Rare
Lansium domesticum Correa	Meliaceae	*Kokosan*	Rare	Rare
Musa acuminata subsp.*acuminata* Colla	Musaceae	*Cau hurang*	Rare	Not rare
Musa balbisiana Colla (genomic group BBB)	Musaceae	*Cau manggala*	Rare	Not rare
Syzygium cumini (L.) Skeels	Myrtaceae	*Jamblang*	Rare	Rare
Syzygium polycehalum (Miq.) Merr. & L.M. Perry	Myrtaceae	*Kupa*	Rare	Rare
Passiflora edulis Sims	Passifloraceae	*Markisa*	Rare	Not rare
Passiflora ligularis Juss.	Passifloraceae	*Konyal*	Rare	Not rare
Antidesma bunius (L.) Spreng.	Phyllanthaceae	*Buni*	Rare	Rare
Baccaurea racemosa (Reinw) Mull.Arg.	Phyllanthaceae	*Menteng*	Rare	Rare
Phyllanthus acidus (L.) Skeels	Phyllanthaceae	*Ceremai*	Rare	Rare
Malus domestica (Suckow) Borkh.	Rosaceae	*Apel malang*	Rare	Not rare
Citrus x aurantium f.*deliciosa* (Ten) M.Hiroe	Rutaceae	*Jeruk garut*	Rare	Not rare
Citrus reticulata Blanco	Rutaceae	*Jeruk ragi*	Rare	Not rare
Nephelium lappacerum L.	Sapindaceae	*Rambutan*	Not rare	Rare
Pometia pinnata J.R.Forst. & G.Forst.	Sapindaceae	*Matoa*	Rare	Rare
Lucuma campechiana Kunth	Sapotaceae	*Campolay*	Rare	Rare

Table 4. Similarity Index of fruit species and landraces sold among three traditional markets, based on Jaccard

Markets	Ji Similarity Index
Gedebage-Ujungberung	0.8448
Ujungberung-Tanjungsari	0.7500
Gedebage-Tanjungsari	0.8148

Table 5. Diversity Index of fruit species sold among three traditional markets, based on Shannon-Wiener

Markets	H'
Gedebage	3.344
Ujungberung	3.355
Tanjungsari	3.485

Traders' perception of rare fruit and fruit scarcity causes

Based on the interview conducted, traders stated that the fruit sold in markets generally comes from village wholesalers who supply it directly to traders. Meanwhile, some other traders purchase their fruit supplies from their garden or garden owners, and they are also aware that some fruit are sourced from forests, even though they do not collect them directly from there. In addition, several fruit species and landraces are considered rare. The sourcing of fruit plants from diverse agroecosystems, as stated by traders, is also observed in various regions. Previous studies conducted in Indonesia (Iskandar et al. 2017, 2020, 2021, 2022, 2023) and in several areas outside Indonesia - including Cina and Vietnam (Nguyen et al. 2019; Luo et al. 2020), Armenia (Nanagulyan et al. 2020), and Ethiopia (Tahir et al. 2023)-reported similar findings, that plants sold in traditional markets are supplied - either cultivated or wild - from various agroecosystems, including rice fields, national parks, vegetable gardens, mountains, forests, mixed gardens, home gardens, and grasslands.

However, in Gedebage, Ujungberung, and Tanjungsari Markets, several fruit species and landraces are identified by traders as rare. This aligns with the statement by Albuquerque et al. (2019), who emphasized that traditional markets act as hallmarks that reproduce biological diversity on a small scale. Therefore, when a fruit species continues to be found frequently in the market, it indicates that its availability in surrounding agroecosystems is well maintained, and vice versa.

According to traders' perception, rare fruits are those that are now seldom or no longer sold in the market. Examples include *M. acuminata* subsp. *acuminata*, which appears in markets only once in 4-5 years with very limited supply (only one bunch in a whole truckload of bananas), and *S. zalacca* from Tasikmalaya, which is no longer sold because it has been replaced by the more commercially popular *salak pondoh* from Banjarnegara (Central Java) and Yogyakarta. Traders identified that there are 25 rare species and landraces of local fruits sold in Gedebage, Ujungberung, and Tanjungsari Markets. The number of fruit species and landraces identified as rare by traders in this study is greater than that reported in earlier studies about rare fruits in Indonesia by Agus et al. (2014), Dodo (2015), Husodo et al. (2018), Pratama et al. (2019), Anggraeni et al. (2023), and Rahayu et al. (2024) (Table 3). This difference occurs because some previous researchers classified fruit rarity based on IUCN criteria, including population size, degree of decline, population trends, and distribution range. These criteria differ from traders' perceptions, which define fruit rarity based on how often a fruit species or landrace is supplied to markets and the volume traded. Since IUCN-based literature on rare fruits is still limited, etic perspectives are often derived from local studies documenting rare fruits in previous studies conducted in other regions. Consequently, fruit regarded as rare in one locality may not be perceived as rare elsewhere.

According to their perceptions and experiences, several factors contribute to fruit rarity, including:

Land-use changes and displacement by commercial commodities

Traders explained that *Diospyros kaki* Thunb. began to disappear from the market in the 1990s because farmers switched to cultivating oranges. Persimmon orchards in Cikijing (Garut) were converted into residential areas. Similarly, *S. dulcis* and *apel malang* (*M. domestica*) became less available in markets because farmers replaced ambarella with watermelons in the 1980s, while apple orchards in Tumpang and Batu (Malang, East Java) began to be replaced by housing developments since around 2010.

The displacement of local fruits due to the expansion of commercial commodities and land-use changes indicates a wider regional pattern. Previous studies conducted in Indonesia (Pratama et al. 2019; Ihsan et al. 2024) and in other regions of East Asia and Southeast Asia (Luo et al. 2019; Cao et al. 2020) reported how both factors influence the presence of local fruits in the market. Pratama et al. (2019) and Ihsan et al. (2024) reported that in several areas in West Java, including Sumedang, Tasikmalaya, and Garut, local communities have begun replacing certain fruit trees with more profitable species. Local fruits such as *A. bunius* and *Annona squamosa* L. are being replaced by *Tectona grandis* L.f., and *Arenga pinnata* (Wurmb) Merr.), which are cultivated for timber, spice, and sap, respectively. Likewise, bamboo (*Gigantochloa apus* (Schult.f.) Kurz and *G. ater* (Hassk.) Kurz ex Munro) are being replaced by commercial vegetable farms. The fruit trees that remain cultivated by local people tend to be commercial species such as pineapple, coconut, and durian. Similar patterns have been observed in China, Laos, and Vietnam, as reported by Luo et al. (2019) and Cao et al. (2020). In these regions, rice cultivation has been gradually replaced by commercial plants such as bananas, watermelons, rubber, and chili, which offer higher economic returns. As a result, rice paddies have been drained, leading to the loss of wetlands that once supported the growth of wild food plants such as *Pouteria grandiflora* (A.DC.) Baehni.

Lack of cultivation

Traders stated fruits that grow naturally without cultivation are called *buah liar* (wild fruits) or *buah leuweung* (forest fruits). Some examples include *konyal* (*Passiflora ligularis* Juss.), bignay (*A. bunius*), *kupa* (*Syzygium polycephalum* (Miq.) Merr & L.M.Perry), custard apple (*A. squamosa*), *menteng* (*Baccaurea racemosa* (Reinw) Mull.Arg.), and horsefruit (*M. foetida*). These wild fruits are mainly supplied from regions of West Java, such as Tasikmalaya, Bogor, and Rancakalong (Sumedang). In contrast, cultivated fruits such as Cavendish banana (*M. acuminata*), jackfruit (*A. heterophyllus* Lam.), *jeruk medan* (*Citrus x aurantium f. aurantium* L.), and water guava (*Syzygium aqueum* (Burm.f.) Alston) are supplied from various regions both inside and outside West Java, including Majalaya (Bandung District), Lampung, and Brastagi (North Sumatra). This difference likely occurs because wild fruits are not cultivated on a large scale, resulting in a limited and inconsistent supply.

The lack of cultivation of these fruits, as reported by traders, reflects a broader regional trend. Previous research both in Indonesia (Pratama et al. 2019; Kulsum and Susandarini 2023; Sagitarian et al. 2023) and outside Indonesia (Ahmad and Pieroni 2016) reported similar findings, namely that the absence of cultivation and supply chain issues for wild fruits prevent them from being supplied in large quantities and sold in a stable, countinous supply. Pratama et al. (2019) and Kulsum and Susandarini (2023) stated that wild fruit like *A. bunius, B. racemosa,* and *A. squamosa* in Tasikmalaya, Garut, and Bogor grows in mixed gardens, home gardens (where local communities grow vegetable and spice crops), coffee plantations, and even cemeteries. Sagitarian et al. (2023) also stated that *jamblang* (*S. cumini)* in Central Java is only sold in small quantities because it lacks large-scale cultivation. Outside Indonesia, Ahmad and Pieroni (2016) also reported that wild vegetables that were traded in Pakistan, including *Ficus palmata* Forssk, was sold through short supply chains, where collectors sold the plants directly to traditional market stalls and consumers.

Unfavorable attributes

Several fruit species and landraces have unfavourable attributes, making them difficult to sell. *Salak lokal* (*S. zalacca*) has a less sweet and somewhat astringent taste, so it must be processed into *manisan* (preserved fruit with sugar) and chips before consumption. *Ceremai* (*Phyllanthus acidus* (L.) Skeels), *jamblang* (*S. cumini*), and *kupa* (*S. polycephalum*) are also extremely sour and must be processed into *manisan. Mangga golek lanang* (*M. indica*) has thin flesh and is small in size, so they have to be eaten by sucking them. *Pepaya thailand* (*Carica papaya* L.) is too large, making it difficult to transport, while *lengkeng lokal* (*Dimocarpus longan* Lour.) has been replaced by longan from Thailand due to its fishy odor. Persimmon and horsefruit contain latex. Persimmon latex makes hands sticky, so farmers remove it by sprinkling its fruit with lime. However, the application of lime not only stains hands but also diminishes the visual appeal of the fruit. Horsefruit latex irritates the throat.

The presence of unfavorable attributes in certain fruit species, as reported by traders, has also been reported in previous studies. Sumarto et al. (2018) noted that *salak manonjaya* from Tasikmalaya (West Java) has been displaced by *salak pondoh* due to its lower sweetness, requiring processing into chips and *manisan*. Dierito et al. (2021) reported that several persimmon cultivars (*D. kaki*) contain high tannin levels that cause an astringent and puckering sensation in the mouth due to protein coagulation. Fitmawati et al. (2021) reported that horsefruit (*M. foetida*) produces more latex and coarser fibers than other species in the *Mangifera*, making it less palatable.

Policy recommendations for local fruit conservation

The problems leading to the rarity of local fruits in traditional markets highlight the importance of fruit conservation efforts. Based on the findings of this study, some policy recommendations are proposed:

Seed banks

A seed bank involves storing plant seeds under controlled conditions - typically at low temperatures (0 to -20 degrees Celsius) to reduce the moisture component to 5%-8%. For recalcitrant seeds that cannot be dried, storage is done in liquid nitrogen at -196 degrees Celsius (Nakum et al. 2025). There are similar findings in several previous studies conducted in Indonesia as well as in other Southeast Asian countries such as Thailand and Brunei Darussalam, which state that seed banks can be used in conservation stages for both cultivated species (including *D. longan* and *Acacia* spp.) and wild species (including *Inga edulis* Mart.) (Suhaili et al. 2015; Kuswantoro and Li'ani 2021; Pratiwi et al. 2022).

Based on this study, fruit species suitable for conservation through seed banking include *P. ligularis* (konyal), *M. foetida* (horsefruit), *A. squamosa* (custard apple), *A. bunius* (bignay), and *S. polycephalum* (*kupa*). These species should be prioritised because their seeds and mature trees are increasingly scarce in natural habitats due to limited cultivation and replacement by commercial crops. Seed banks can support population recovery and large-scale cultivation while preventing genetic drift and loss of genetic diversity that may raise extinction risk. The seeds can be deposited at the National Research and Innovation Agency (Indonesia) for further propagation.

Development of processed products from local fruits

There are several fruit species found in Gedebage, Ujungberung, and Tanjungsari Markets that, although perceived by traders as becoming increasingly rare, are still sold in limited quantities because they are still utilized by local communities for various purposes. These include *D. kaki* (processed into jam), *S. dulcis* (processed into fruit salad/*rujak*), *S. cumini, S. polycephalum*, and *P. acidus* (the latter three processed into candied fruits/*manisan*). All of these fruits have the potential to be developed into large-scale and more commercially viable processed products. Local knowledge regarding the use of local fruits, particularly rare fruits as reported by traders, has been documented in previous studies both in Indonesia (Suwardi et al. 2023) and outside Indonesia (Garcia-Yi 2014; Meena et al. 2022).

In Bolivia, local chili (*Capsicum* spp.) is rarely cultivated due to low market demand and cheap prices. Therefore, efforts have been made to produce chili-based products such as chili jam, chili paste, and pickled chilies. The results showed that consumers were willing to pay a 25%-50% price premium, which is expected to increase farmers' profit and consequently enhance the conservation of the chili plants (Garcia-Yi 2014). Similarly, in India, fruits such as *A. squamosa* and *S. cumini*—both considered rare in Indonesia—are processed into various products, including food and beverages such as jam, juice, jelly, and pickles, as well as non-food products such as massage oil, soap, and perfume (Meena et al. 2022). In Indonesia, horsefruit (*M. foetida*) is still sold in Aceh, where its prices increase significantly when processed (IDR 10,000 per fresh fruit, compared to IDR 40,000 per bottle of juice) (Suwardi et al. 2023). However, before these products can

be developed, a marketing system involving farmers, fruit traders, and fruit processing businesses must first be established.

Farmer-trader information exchange platform and local fruit festival

As noted earlier, traders mainly source fruits from wholesalers rather than directly from farmers. To improve information flow and stabilise supplies—preventing both shortages (or local fruit disappearance) and oversupply that leads to spoilage and losses—a cooperative system is needed to enable direct communication between farmers and traders. Information should cover consumer demand for specific fruit species/landraces, emerging popular processed products from rare fruits, and trader-level prices after receiving stock from wholesalers. Access to these price data can help farmers secure fair profits and reduce the risk of price manipulation in farmer–wholesaler transactions.

The farmer-trader cooperation system can also coordinate with the West Java Department of Food to introduce local fruit products – both commercial and rare species- to the public through exhibitions or festivals. Various products can be promoted, including jam, juice, and chips. The species of fruits promoted can vary depending on the harvest seasons. For example, durian typically appears in Indonesia from January to March, whereas mango and ambarella are commonly available from April to June. A similar activity to the local fruit festival proposed in this study – although conducted in the context of a traditional ritual rather than a government-led initiative to formally promote local plants commodities- reflects broader regional trends. Tamang et al. (2016) and Uro-Chukwu (2024) document similar findings, namely how local communities utilize local plant species in traditional festivals. Tamang et al. (2016) document that *selroti* (maize-based food from fermented rice) is used in the *Diwali* festivals for celebrating the New Year in several Hindu communities in India. Uro-Chukwu (2024) also reported that in Nigeria several ethnic groups-namely the Igbo, Yoruba, and Hausa- hold a festival called *Ikeji,* which is a ritual celebration of the annual harvest of yam bean (*P. erosus*). Several yam bean-based products are sold at the festival, including boiled, roasted, fried, and legume-cooked versions.

Folk classification of crops and characteristics of fruit landraces

Traders in Gedebage, Ujungberung, and Tanjungsari apply a four-level folk classification system. At level 0 (unique-beginner), crops are grouped into tutuwuhan (wild plants) and pepelakan (cultivated plants). At level 1 (life form), they are categorised by growth position and food use into bubuahan (fruits), sayuran (vegetables), and beubeutian (tubers). At level 2 (specific), fruits are organised into types roughly equivalent to botanical species (e.g., mangga, cau), and at level 3 (varietal) each type is subdivided into landraces. Knowledge of landrace types and traits is mainly learned through peer traders and village wholesalers.

Landraces are within-species variants recognised by local communities based on observable traits (e.g., colour, size, taste) rather than genetic analysis (Iskandar et al. 2018a). In this study, examples include mangga gedong (mango) and *cau raja cere* (banana). Traders in Gedebage, Ujungberung, and Tanjungsari distinguish fruit landraces using criteria such as origin, taste, utilisation, and shape. They may also group botanically distinct species into a single folk type when they look similar, as seen in bananas (*Musa balbisiana* Colla, *M. acuminata*, and *M. × paradisiaca*). The overall crop folk classification is summarised in Table 6, and the fruit landraces with their distinguishing features are listed in Table 7.

The inventory and interview data indicate that traders in Gedebage, Ujungberung, and Tanjungsari Markets possess deep knowledge in identifying the characteristics of fruit landraces. They categorize the food plants they sell into several categories, classify them into several hierarchical levels, and divide fruit plants into distinct landraces based on various aspects. The division of fruit plants, as reported by traders, indicates a wider regional pattern. Previous studies conducted both inside and outside Southeast Asia by Cruz-Garcia and Prince (2011), Ueda et al. (2016), and Nakintu et al. (2019) documented similar findings, namely how local communities perform these three practices in classifying food plants, particularly fruits. Cruz-Garcia and Prince (2011) and Ueda et al. (2016) stated that plants in Thailand were initially categorized into *bak/maak* (fruits) and *phak* (vegetables). Mangoes, which are naturally classified as fruits, were referred to as *muang*, which was further divided into several local names, such as *muang faai* (*M. caloneura* Kurz), and *muang prio* (*M. sylvatica* Roxb.), differentiated based on several aspects, including their uses, shape, and fruit taste. Similarly, in Uganda, local communities distinguish jackfruit (*A. heterophyllus*) into several landraces - *jebu, namata,* and *kapapali* - based on the texture and color of the fruit flesh (Nakintu et al. 2019).

Table 6. Folk classification of crops traded in traditional markets (adapted from Irawan et al. (2024))

Level	Botanical classification	Folk classification	Classification hierarchy
0	Wild crops	*Tutuwuhan*	*Unique-beginner*
	Cultivated crops	*Pepelakan*	
1	Fruits	*Bubuahan*	Life-form
	Vegetables	*Sayuran*	
	Tubers	*Beubeutian*	
2	Species	*Pisang/cau*	Spesific
		Mangga	
3	Landraces of banana/*cau* (*M. x paradisiaca* L. (genomic group AAA))***	*Cau ambon lumut biasa*	Varietal
		Cau ambon bodas	
	(*M. x paradisiaca* L. (genomic group AAB))***	*Cau raja cere*	
		Cau raja bulu	
		Mangga arumanis	
	Landraces of mango/*mangga* (*M.indica* L.)	*Mangga gedong*	

Note: ***: Based on Iskandar et al. (2018b) and Poerba et al. (2018)

Table 7. Fruit landraces characteristics and distinguishing aspects

Species name	Landraces number	English name	Landraces vernacular name	Distinguishing characteristics
Mangifera indica L.	16	Mango	*Mangga arumanis* *Mangga arumanis bali* *Mangga cengkir* *Mangga gedong* *Mangga gedong gincu* *Mangga golek* *Mangga golek lanang* *Mangga benhur* *Mangga manalagi* *Mangga budiraja* *Mangga mawar* *Mangga red emperor* *Mangga TO* *Mangga kopyor* *Mangga benhur* *Mangga alpukat*	Skin color, shape, flesh texture, flesh color
Salacca zalacca (Gaertn.) Voss	2	Snakefruit	*Salak lokal* *Salak pondoh*	Origin, taste, utilization
Phoenix dactylifera L.	4	Dates	*Korma ajwa* *Korma barhi* *Korma sukary* *Korma golden valley*	Stalk presence, flesh texture, taste
Ananas comosus L.	5	Pineapple	*Ganas subang* *Ganas palembang* *Ganas bogor* *Ganas kediri* *Ganas madu*	Durability, size, shape
Carica papaya L.	3	Papaya	*Gedang california* *Gedang thailand* *Gedang calina*	Size, skin texture
Citrullus lanatus L.	4	Watermelon	*Samangka nonbiji* *Samangka golden* *Samangka inul* *Samangka dragon*	Shape, skin color, seeds presence
Cucumis melo L.	2	Melon	*Melon* *Bonteng suri*	Shape, skin morphology, fruit flesh color
Pachyrhizus erosus (L.) Urb.	3	Jicama	*Bengkuang padalarang* *Bengkuang lampung* *Bengkuang garut*	Diameter, texture, water content
Persea americana L.	7	Avocado	*Alpukat mentega* *Alpukat susu* *Alpukat lokal* *Alpukat miki* *Alpukat markus* *Alpukat aligator* *Alpukat minyak*	Shape, flesh texture, diameter
Durio zibethinus L.	7	Durian	*Kadu lokal* *Kadu montong* *Kadu musang king* *Kadu hejo* *Kadu sumatra* *Kadu petruk* *Kadu bawor*	Shape, diameter, skin and fleh color
Lansium domesticum Correa	5	Langsat	*Dukuh palembang* *Dukuh ciamis* *Langsat* *Pisitan* *Kokosan*	Diameter, skin texture and thickness, number of seeds, taste, skin color
Musa acuminata Colla (genomic group AA)	13	Banana	*Cau muli* *Cau bangkahulu* *Cau mas/kirana* *Cau ketan* *Cau barangan* *Cau hurang*	Length, diameter, utilization, apex shape, skin texture, skin color, origin, ripening method

Species name	Landraces number	English name	Landraces vernacular name	Distinguishing characteristics
Musa acuminata Colla (genomic group AAA)			*Cau ambon lumut biasa* *Cau ambon lumut lembang* *Cau ambon lumut palintang* *Cau ambon bodas* *Cau cavendish* *Cau angleng* *Cau kapas*	
Musa balbisiana Colla	2	Banana	*Cau galeng* *Cau manggala*	Utilization, presence of seeds
Musa x paradisiaca L. (genomic group AAB)	16	Banana	*Cau tanduk biasa* *Cau tanduk kompan* *Cau tanduk sukabumi* *Cau nangka* *Cau bogo* *Cau raja bulu* *Cau susu* *Cau raja cere* *Cau lampeneng*	Origin, flesh texture, flesh color, utilization, skin color, shape, length, diameter, taste, seeds presence, skin thickness, mature time
Musa x paradisiaca L. (genomic group ABB)			*Cau kepok saba* *Cau kepok jablay* *Cau siem paris* *Cau siem jimluk* *Cau ampeang* *Cau bawen* *Cau kastroli*	
Musa x paradisiaca L. (genomic group AAAB)				
Psidium guajava L.	2	Guava	*Jambu biji* *Jambu kristal*	Seeds presence, flesh color
Syzygium aqueum (Burm.f.) Alston	3	Water apple	*Jambu air* *Jambu air kancing* *Jambu cincalo*	Shape, size
Malus domestica (Suckow) Borkh.	6	Apple	*Apel malang* *Apel royal gala* *Apel manalagi* *Apel granny smith* *Apel fuji* *Apel merah*	Origin, taste, skin color, utilization
Citrus x limon (L.) Osbeck	2	Lemon	*Lemon lokal* *Lemon impor*	Origin, taste
Vitis vinifera L.	6	Grape	*Anggur red globe* *Anggur crimson* *Anggur thomson* *Anggur muscat* *Anggur moonrop* *Anggur autum*	Origin, size, shape, skin color
Pyrus bretschneideri Rehder	2	Chinese pear	*Pir yali* *Pir xiang lie*	Texture, skin color
Pyrus communis L.	2	Asian Pear	*Pir forelle* *Pir century*	Shape, flesh texture, skin color
Pyrus pyrifolia (Burm.fill) Nakai	2	European Pear	*Pir jambu* *Pir singo*	Skin color, shape
Citrus x aurantium f. aurantium L.	5	Bitter orange	*Jeruk medan* *Jeruk peras* *Jeruk jember* *Jeruk sunkist maple*	Utilization, origin, skin color, diameter

Species name	Landraces number	English name	Landraces vernacular name	Distinguishing characteristics
			Jeruk sunkist valencia	
Citrus reticulata Blanco	9	Mandarin orange	*Jeruk wogan* *Jeruk wokam* *Jeruk santang tangerine* *Jeruk santang birma* *Jeruk santang daun* *Jeruk santang madu* *Jeruk santang gundul* *Jeruk garut* *Jeruk ragi*	Origin, size, taste, skin color, leaves presence

Based on the results of this study, it can be seen that traditional markets serve as centers for dissemination and exchange of local knowledge regarding fruit landraces. Such knowledge is not static, as evidenced by the presence of imported fruit landraces that have entered markets. This folk knowledge can serve as an important basis for conservation of both species and landraces of fruits, particularly local ones.

RFC value of fruits

The RFC (Relative Frequency of Citation) values of fruit species and landraces sold in Gedebage, Ujungberung, and Tanjungsari Markets varied between 0.012 and 0.517 (Table 2). For example, traders only selling coconuts or California papaya (*C. papaya*). In addition, several traders, although selling a diverse range of fruit landraces, referred to the same species - such as banana sellers (*M. acuminata* and *M. x paradisiaca*). It can thus be inferred that traders' knowledge regarding the utilization of different fruit species and landraces was uneven. The higher the RFC value of a fruit, the more frequently its uses were known and mentioned by the respondents, and vice versa. Several fruit species and landraces showed the highest RFC values, namely melon (*Cucumis melo* L.), dragon fruit (*S. undatus*), California papaya (*C. papaya*), *cau muli* (*M. acuminata*), and several *M. x paradisiaca* landraces such as *cau ambon lumut, cau ambon bodas,* and *cau raja cere.* On the other hand, several fruit species and landraces had low RFC values, such as plum (*Prunus domestica* L.), java plum/*jamblang* (*S. cumini*), bignay/*buni* (*A. bunius*), *ceremai* (*P. acidus*), *menteng* (*B. racemosa*), and several mango (*mangga/M. indica*) landraces, including *mangga kidang* and *mangga kopyor.*

The variation in RFC values indicates differences in the level of familiarity with fruit species and landraces among traders and consumers. These differences are influenced by several factors, including accessibility, utility, and fruit attributes. The high RFC values of melon, papaya, dragon fruit, *cau muli*, and several *M. x paradisiaca* landraces are due to diverse uses. For instance, dragon fruit is used as an ingredient of fruit soup (*sop buah*) and cake mixture and as a remedy for hypertension. Likewise, *M. acuminata* and *M. x paradisiaca* can be directly consumed, made into juice, and also used as ingredients for several cakes, such as *bolu* and *pisang lumpur*. The continued use of these fruit species and landraces, as stated by traders, mirrors broader trends across the region. Previous research conducted in Indonesia (Darmastuti et al. 2024; Suwardi et al. 2024; Safitri et al. 2025) as well as in other parts of the world – particularly Southeast and South Asia (Shuaib et al. 2019; Semenya and Maronyi 2020; Gamage et al. 2021; Cabugatan et al. 2022; Anwar et al. 2024; Saensouk et al. 2025a) – has documented similar patterns, namely how local communities have utilized several fruit species and landraces (bananas, dragon fruit, and papaya) for various purposes, including direct consumption, medicinal uses, and traditional rituals. Furthermore, all these fruits have been intensively cultivated, making them easy to obtain.

On the other hand, traders stated that *menteng* and bignay grow wild and therefore cannot be supplied in larger quantities, resulting in limited availability. In addition, *ceremai* and *jamblang* have a sour taste and are not as widely utilized as commercial fruits, they are mostly processed into fruit salad and candied fruits (*manisan buah*), aside from being eaten fresh. Even in these processed foods, *ceremai* has begun to be replaced by some commercial fruits such as jicama (*P. erosus*), *mangga cengkir* (*M. indica*), and pineapple (*Ananas comosus* L.), as indicated by the higher RFC values for these fruits. This condition is presumed to result from a shift in fruit consumption patterns and the gradual loss of familiarity of bignay, *jamblang, ceremai,* and *menteng* among the public. The declining use of certain fruit species, as reported by traders in this study, and the researcher's assumption of a shift of fruit-consumption patterns in local communities, have begun to occur in various regions. Previous research conducted in Indonesia (Pratama et al. 2019; Rahayu et al. 2024), as well as in Southeast and East Asia (Ng et al. 2017; Cao et al. 2020), reports similar findings, noting both the erosion of knowledge regarding certain fruit species (particularly among younger generations) and the displacement of local fruit species by commercial fruits. Unlike other fruits, the low RFC value of plums is attributed to Indonesia's climatic conditions, which are unsuitable for their growth. Torrecillas et al. (2018) stated that plums require low temperatures to break dormancy, whereas Indonesia has a tropical climate. In addition, several mango landraces have low RFC values because they are known only locally in a single market.

Traders' knowledge on fruit utilization

Consumed fresh and simply processed

Traders stated that several fruit species are consumed directly, including starfruit (*Averrhoa carambola* L.), *menteng* (*B. racemosa*), papaya (*C. papaya*), durian (*Durio zibethinus* L.), melon (*C. melo*), date (*P. dactylifera*), and several landraces of banana/*pisang/cau* (*M. acuminata* and *M. x paradisiaca*), such as *pisang raja bulu, pisang cavendish, pisang muli,* and *pisang ambon lumut*. In addition to being sold as whole fruits, traders also sell them as sliced fruits packed in plastic. There are also several other banana landraces that are simply processed without any additional ingredients before being served, including *cau tanduk, cau nangka, cau kapas, cau kastroli,* and *cau bawen* (fried), *cau siem paris* (boiled), and *cau raja bulu* (steamed and boiled). All of these banana landraces belong to three species, namely *Musa* spp., *M. x paradisiaca*, and *M. acuminata*. The demand for certain fruit species increases during specific times of the year. For example, dates are widely sold during the month of Ramadan as a staple food for breaking the fast, while *pisang ambon lumut* and *pisang raja bulu* experience higher demand before Eid al-Fitr, as they are commonly served as table fruits for guests visiting homes.

The use of fruits for direct consumption and simple processing, as informed by traders, is part of a broader pattern occurring across many areas. Previous research conducted in Indonesia (Erawan et al. 2019; Rahayu et al. 2024) as well as in several countries outside Indonesia (Shuaib et al. 2019; Semenya and Maronyi 2020; Belgica et al. 2021; Cabugatan et al. 2022; Wongwaiwech et al. 2022) identified comparable patterns in how local communities consume fruit directly or process them in simple ways, either for food purposes or for other needs. Durian, melon, papaya, and *menteng* are eaten fresh not only by the people of Rancakalong (Sumedang District, West Java), but also in other regions such as the Philippines, South Africa, and Pakistan (Shuaib et al. 2019; Semenya and Maronyi 2020; Belgica et al. 2021; Rahayu et al. 2024). Some fruit species and landraces are not only eaten directly but also further processed or used for non-food purposes. Menteng is also processed into *rujak* (fruit salad) by the people in Rancakalong, while in Karangwangi Village (Cianjur, West Java) and in Thailand, bananas are also processed by frying and made into banana chips (Erawan et al. 2019; Wongwaiwech et al. 2022; Rahayu et al. 2024). Melon and papaya are also used as remedies to enhance fertility and to treat dengue fever in Pakistan and the Philippines (Shuaib et al. 2019; Cabugatan et al. 2022).

Fruit juices and fruit hampers

Several fruit species are used for juices, including *M. acuminata*, avocado (*Persea americana* L.), strawberry (*Fragaria vesca* L.), and pineapple (*A. comosus*). All of these fruits are processed into juice to be used as beverage ingredients. Fruits intended for juicing are sold to juice vendors either in whole form or after being frozen (known as *buah frozen*). The fruits to be frozen are first cut into smaller pieces or crushed (especially for small-sized fruits like strawberries), then placed in Ziploc plastic bags and stored in a refrigerator. The price per kilogram of the frozen fruit is higher than that of whole fruit, as frozen fruit consists only of the edible flesh – the skin and seeds have already been removed. In other words, the amount of edible flesh in frozen fruit is greater than in whole fruit. Frozen fruits served as backup stock, especially for seasonal species, including durian (*D. zibethinus*) when they are out of season.

Fruit hampers are baskets or packages containing an assortment of fruits, often wrapped in plastic. Consumers' demand for fruit hampers usually increases before the Eid al-Fitr holiday, although some customers also order them on ordinary days as gifts. The prices of the hampers range from IDR100,000 to IDR150,000, depending on customer requests. Several fruit species are commonly used in fruit hampers including a*nggur red globe* (*Vitis vinifera* L.), *jeruk medan* (*C. x aurantium*), *apel fuji* (*M. domestica*), and *pisang cavendish* (*M. acuminata*).

The use of fruits for making juice or arranging fruit bouquets, as reported by traders, indicates a wider pattern observed in many regions. Previous studies conducted in Indonesia (Navia et al. 2024) as well as in areas outside Indonesia (Anu et al. 2023; Das et al. 2023) identified comparable patterns in how local communities engage in these practices, whether for food purposes or for other uses. Avocado, pineapple, and banana are also used for making juice for making juice in Bandar Pusaka (Aceh Province, Indonesia) and in India (Anu et al. 2023; Das et al. 2023; Navia et al. 2024). It should be noted that pineapple and banana juice are not made as desserts but rather used as traditional remedies for diabetes and liver disorders (Anu et al. 2023; Das et al. 2023).

Medicinal uses

Several fruit species are known by traders to be used for treating health disorders, including *M. foetida* (*limus*/horsefruit), *D. kaki* (persimmon), *P. ligularis* (sweet granadilla/*konyal*), and *S. undatus* (dragon fruit). Horsefruit and persimmon are used to treat stomach disorders, while *konyal* and dragon fruit are used, respectively, to relieve *panas dalam* (a respiratory condition characterized by throat pain when swallowing) and to lower high blood pressure. All of these fruits are used as medicine by being consumed directly.

The use of fruit to treat various illnesses, as stated by traders, mirrors a wider pattern observed elsewhere. Previous studies conducted in Indonesia (Nursamsu et al. 2024), as well as in several other countries across different regions in the world (Boudaia et al. 2024; Ul Abidin et al. 2024), recorded similar observations regarding how local communities use fruits to maintain their health. Horsefruit has been traditionally used by the people of South Aceh to treat diarrhea, while persimmon has been used in Pakistan to treat stomach pain and constipation (Ul Abidin et al. 2024; Nursamsu et al. 2024). In addition, *konyal* is used in Ecuador to treat respiratory disorders, and dragon fruit is used in Morocco to treat cancer (Boudaia et al. 2024).

Earlier research performed by Khoo et al. (2016), Aboellella et al. (2021), Angel-Isaza et al. (2021), Güler et al. (2021), Choudhary et al. (2022) and Habiba et al. (2025)

indicated that scientific research of the health effect of fruits aligns with and reinforces the empirical knowledge reported by traders in this study. Horsefruit, *konyal,* and dragon fruit contain antioxidants and anti-inflammatory compounds such as harmanes, isoflavones, carotenoids, polyphenols, and phenolic acids, which play an important role in preventing inflammation and oxidative stress. Oxidative stress contributes to increased blood pressure and triggers cancer and inflammation in the body (Khoo et al. 2016; Aboellella et al. 2021; Angel-Isaza et al. 2021; Habiba et al. 2025). Meanwhile, persimmon contains tannins that facilitate peristaltic movement in the esophagus, aid in toxin elimination, and inhibit genes involved in inflammatory processes including *Caspase-3* (Güler et al. 2021; Choudhary et al. 2022).

Use in traditional rituals

Several fruit species are used in certain rituals according to traders' knowledge, including jicama (*P. erosus*), ambarella/*kedondong* (*S. dulcis*), pomegranate (*Punica granatum* L.), *pisang mas* (*M. acuminata*), and *pisang ambon lumut* (*M. x paradisiaca*). *Pisang mas* is used in wedding ceremonies, while *pisang ambon* is used in *pangradinan* (offering to jinn). Pomegranate, jicama, and ambarella are used in the *ritual nujuh bulan*, which celebrates pregnancy upon entering the seventh month.

The use of fruits in certain ritual practices, as reported by traders, demonstrates a trend that extends across the regions. Previous studies conducted in Indonesia – both in West Java (Erawan et al. 2018; Aziz et al. 2019; Gardjito et al. 2024) and outside the province (Hapsari et al. 2017; Untari et al. 2017; Mukarromah et al. 2024) – as well as in several regions beyond Indonesia (Bagartee and Swain 2024; Saensouk et al. 2025a) document similar findings, showing how local communities ascribe specific philosophies to these rituals, symbolized through the use of fruits. In West Java, bananas (*M. x paradisiaca*) are used in wedding rituals called *ngeuyeuk seureuh* as offerings symbolizing happiness. Bananas are also used in Central Java in wedding ceremonies as symbols of the hope that the couple will love, understand, and care for each other (Aziz et al. 2019; Mukarromah et al. 2024). In East Java, bananas are used in rituals marking important life stages (birth, circumcision, marriage, and death). The landraces *pisang raja sajen* and *pisang raja pulut* symbolize wisdom, prosperity, happiness, and the hope of being freed from misfortune. In India, banana fruits and leaves are offered to gods Vishnu, Ganesha, and Lakhsmi (Hapsari et al. 2017; Bagartee and Swain 2024).

Jicama, ambarella, and pomegranate are used in pregnancy-related rituals across several Indonesian provinces, each with different philosophical meanings. In West Java, these three fruits are used in the preparation of *rujak kanistren* (fruit salad), symbolizing the end of the mother's childhood and her transition into adulthood, as well as the lessons of life's bitterness to be passed to her children. In Central Java, jicama, along with mango and coconut, symbolizes gratitude to God and the hope for the safety of both mother and her child. Meanwhile, in Jakarta, pomegranate represents the wish for the baby to be loved by everyone and to be born with a pleasant appearance (Untari et al. 2017; Erawan et al. 2018; Gardjito et al. 2024 Mukarromah et al. 2024).

In Thailand, jicama and bananas (*M. acuminata*) are used in *Bhun Kao Phradap Din* and *Khao Sak* rituals, held in the 9th and 10th lunar months, respectively, to honor the spirits of deceased relatives by offering them food. It is believed that on the 14th day of the 9th lunar month, the gates of hell open, allowing the spirits of the dead and supernatural beings to enter the human world (Saensouk et al. 2025a).

Based on the results of this study and comparison with other research, it can be seen that traditional markets play a role not only in biodiversity conservation but also in cultural conservation, since the fruits needed to perform these cultural traditions are still sold there. The findings reinforce the statement of Albuquerque et al. (2019), which asserts that traditional markets serve as venues for reproducing cultural diversity on the small scale, in addition to biodiversity. Furthermore, the relationship between markets and cultural diversity has been documented in previous studies conducted by Iskandar et al. (2020, 2022) and Saensouk et al. (2025b) in Beringharjo Market (Yogyakarta), Karangwangi Village Market (Cianjur District, West Java), and Chai Chumpol Temple Market (Thailand), respectively. In both markets, various plant species are still sold, as they are used by local people for various purposes, including *Calamus* sp. (used as handicraft material), *Lagenaria siceraria* (Molina) Standl. (used as food sources), *C. annuum* (used as medicine), and *Areca catechu* L. (used in traditional rituals).

A total of 170 fruit species and landraces (128 local) were recorded, including 25 rare landraces threatened by unfavourable traits, limited cultivation, land-use change, and competition from commercial commodities. These findings underscore traditional markets as key observatories for monitoring local fruit diversity, hubs for exchanging knowledge on landraces, and small-scale sites where biological and cultural diversity is reproduced. Policymakers, BRIN, farmers, and traders can strengthen this role through seed banking, value-added product development, local fruit festivals, farmer–trader cooperation, and integrated market systems that support agrobiodiversity conservation and SDG 15. Without such efforts, the loss of local fruit biodiversity and associated traditional knowledge may accelerate and become irreversible. Future research should examine policy frameworks and participatory mechanisms to sustain these initiatives.

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REFERENCES

Aboellella NS, Brandle NS, Kim T, Ding Zin-Chun. Zhou G. 2021. Oxidative stress in the tumor microenvironment and its relevance to cancer immunotherapy. Cancers 13 (5): 1-23. 10.3390/cancers13050986.

Adinugraha F, Zubaidah S, Lestari SR, Chua KH. 2024. Ethnobiology of plants and animals used as ubarampe in the Kepungan tradition of the Javanese Community of Somongari, Purworejo District, Indonesia. Biodiversitas 25 (8): 2521-2532. DOI: 10.13057/biodiv/d25082.

Agus C, Adriyanti DT, Syahbudin A, Basori AF. 2014. Rare Indonesian Plants in KP4 UGM. UGM Press, Yogyakarta [Indonesian]

Ahmad K, Pieroni A. 2016. Folk knowledge of wild food plants among the tribal communities of Thakht-e-Sulaiman Hills, North-West Pakistan. J Ethnobiol Ethnomed 12: 17. DOI: 10.1186/s13002-016-0090-2.

Albuquerque UP, Monteiro JM, Ramos MA, Cavalcanti de Amorin EL, Alves RRN. 2019. Ethnobiological research in public markets. In: Albuquerque UP, Cruz da Cunha LVZ, Paiva de Lucena RF, Alves RRN (eds). Methods and Techniques in Ethnobiology and Ethnoecology. Humana Press: New York, (2nd edition) DOI: 10.1007/978-1-4939-8919-5.

Alfinandah A, Irawan B, Iskandar J. 2025. Ethnobotany of wild edible plants by the community of Cijambu Village, Sumedang District, West Java, Indonesia. Biodiversitas 26 (5): 2235-2252. DOI: 10.13057/biodiv/d260521.

Amarullah ET, Trizelia, Yaherwandi, Hamid H. 2017. Diversity of plant species in paddy ecosystem in West Sumatra, Indonesia. Biodiversitas 18 (3): 1218-1225. DOI: 10.13057/biodiv/d180346.

Angel-Isaza J, Carmona-Hernandez JC, Narvaez-Solarte M, Gonzalez-Correa CH. 2021. Polyphenols from *Passiflora ligularis* regulate inflammatory markers and weight gain. Biomolecular Concepts 12 (1): 36-45. DOI: 10.1515/bmc-2021-0005.

Anggraeni A, Yuniati R, Silalahi M, Lestari R, Jumari. 2023. Cultivation of underutilized fruit trees by indigenous people in Urug Village, West Java, Indonesia. Biodiversitas 24 (1): 454-466. DOI: 10.13057/biodiv/d240152.

Anu IJ, Jahan R, Bashar ABMA, Rahmatullah M. 2023. An ethnomedicinal survey on folk medicinal uses of plants in eastern Madhupur region of Pabna District, Bangladesh. J Med Plants Stud 11 (1): 200-207. DOI: 10.22271/plants.2023.v11.i1c.1530.

Anwar S, Qureshi H, Sarwar G, Siddiqi EH, Ahmad A. 2024. Exploring ethnomedicinal plants for primary health care needs in rural communities. Ecol Front 44: 1187-1196. DOI: 10.1016/j.ecofro.2024.06.003.

Aziz IR, Anita RPR, Susilo, Nasution J. 2019. Ethnobotany of traditional wedding: A comparison of plants used by Bugis, Palembang, Sundanese and Karo ethnic in Indonesia. J Phys: Conf Ser 1175: 1-7. DOI: 10.1088/1742-6596/1175/1/012005.

Bagartee D, Swain M. 2024. Study of some medico-religious plants in the tribal localities of Bargarh District, Odisha, India. Asian J Res Bot 7 (1): 84-93.

Belgica THR, Suba MD, Alejandro GJB. 2021. Quantitative ethnobotanical study of medicinal flora used by local inhabitants in selected Barangay of Malinao, Albay, Philippines. Biodiversitas 22 (7): 2711-2721. DOI: 10.13057/biodiv/d220720.

Boonma T, Saensouk S, Saensouk P. 2023. Diversity and traditional utilization of the Zingiberaceae plants in Nakhon Nayok Province, Central Thailand. Diversity 15 (8): 1-53. DOI: 10.3390/d15080904.

Boudaia O, El Youbi AEL, Sekkout Z, Moustakbal C, Ismaili N, Elamrani N, Radallah D. 2024. Ethnopharmacological investigation and traditional cultural use of anticancer medicinal plants in Morocco's Casablanca-Settat region. Ethnobot Res Appl 28 (27): 1-49. DOI: 10.32859/era.28.27.1-49.

Bussmann RB, Zambrana MYP, Huanca LAM, Hart R. 2016. Changing markets – medicinal plants in the markets of La Paz and El Alto, Bolivia. J Ethnopharm 193: 76-95. DOI: 10.1016/j.jep.2016.07.074.

Cabugatan MAD, Ong RLJT, Mancao LS, Lumogdang LP. 2022. Ethnobotanical survey on medicinal plants used by the Manobo tribe of Don Marcelino, Davao Occidental, Philippines. Asian J Biol Life Sci 11 (2). DOI: 10.5530/ajbls.2022.11.67.

Cao Y, Li R, Zhou S, Song L, Quan R, Hu H. 2020. Ethnobotanical study on wild edible plants used by three trans-boundary ethnic groups in Jiangcheng County, Pu'er, Southwest China. J Ethnobiol Ethnomed 16 (66): 1-23. DOI: 10.1186/s13002-020-00420-1.

Choudhary R, Singh A, Uphadyay A, Singh R, Thangalashmi S, Dar AH, Bajpai VK, Shukla S. 2022. Exotic god fruit, persimmon (*Diospyros kaki*): Pharmacological importance and human health aspects. eFood 4 (1): 1-13. DOI: 10.1002/efd2.52.

Cruz-Garcia GS, Price LL. 2011. Ethnobotanical investigation of 'wild' food plants used by rice farmers in Kalasin, Northeast Thailand. J Ethnobiol Ethnomed 7: 33. DOI: 10.1186/1746-4269-7-33.

Darmastuti SA, Nazar IA, Setyawan AD. 2024. Plant diversity and its use in Javanese urban home garden: An ethnobotanical study in Central Java, Indonesia. Asian J Ethnobiol 7 (1): 32-42. DOI: 10.13057/asianjethnobiol/y070104.

Darsono BS, Hikmat A, Soekmadi R. 2022. Ethnobotany of *Kemang* (*Mangifera kemanga* Blume.) as identity flora of Bogor Regency. Media Konservasi 27 (2): 34-41. DOI: 10.29244/medkon.27.2.34-41.

Das J, Acharya BC, Mallick SN. 2023. Traditional ethno-medicinal plants used for treatment of diabetes by Bhuyan tribes in Sundargarh District of Odisha, India: An ethnobotanical survey. Plant Sci Today 10 (3): 58-67. DOI: 10.14719/pst.2030.

Direito R, Rocha J, Sepodes B, Eduardo-Figueira M. 2021. From *Diospyros kaki* L. (persimmon) phytochemical profile and health impact to new product perspectives and waste valorization. Nutrients 13 (9): 3283. DOI: 10.3390/nu13093283.

Dodo. 2015. Keanekaragaman dan konservasi tumbuhan buah langka. Warta Kebun Raya 13 (2): 37-41 [Indonesian]

Erawan TS, Alillah AN, Iskandar J. 2018. Ethnobotany of traditional rituals in the Karangwangi Village, Cianjur District, West Java, Indonesia. Asian J Ethnobiol 1 (2): 53-60. DOI: 10.13057/asianjethnobiol/y010201.

Erawan TS, Hidayat RA, Iskandar J. 2019. Ethnobotanical study on banana in Karangwangi Village, Cianjur District, West Java. Jurnal Biodjati 4 (1): 112-125. DOI: 10.15575/biodjati.v4i1.2954.

FAO C. 2021. Fruit and Vegetables: Opportunities and Challenges for Small-scale Sustainable Farming. FAO, Rome. DOI: 10.4060/cb4173en.

Faruque MO, Feng G, Khan MNA, Barlow JW, Ankhi UR, Hu S, Kamaruzzaman M, Uddin SB, Hu X. 2019. Qualitative and quantitative ethnobotanical study of the Pangkhua community in Bilaichari Upazilla, Rangamati District, Bangladesh. J Ethnobiol Ethnomed 15 (1): 8. DOI: 10.1186/s13002-019-0287-2.

Fitmawati, Safitri M, Khofifah SN, Emrizal, Roza RM. 2021. *Mangifera foetida* L. (macang) source of potent antiviral activity of against Dengue Virus serotype 2 (anti-DENV2). J Phys: Conf Ser 2049: 012018. DOI: 10.1088/1742-6596/2049/1/012018.

Franco FM, Chaw LL, Bakar N, Abas SNH. 2020. Socialising over fruits and vegetables: The biocultural importance of an open-air market in Bandar Seri Begawan, Brunei Darussalam. J Ethnobiol Ethnomed 16 (1): 6. DOI: 10.1186/s13002-020-0356-6.

Franco FM, Knudsen M, Hassan NH. 2022. Case Studies in Biocultural Diversity from Southeast Asia-traditional ecological Calendars, Folk Medicines, and Folk Names. In: Franco FM, Knudsen M, Hassan NH (eds). Case Studies in Biocultural Diversity from Southeast Asia-Traditional Ecological Calendars, Folk Medicines, and Folk Names. Springer Nature Singapore, Singapore. DOI: 10.1007/978-981-16-6719-0.

Gamage DGND, Dharmadasa RM, Abeysinghe DC, Wijesekara RGS, Prathapasinghe GA, Someya. 2021. Ethnopharmacological survey on medicinal plants used for cosmetic treatments in traditional and ayurveda systems of medicine in Sri Lanka. Evid Based Complement Alternat Med 2021: 5599654. DOI: 10.1155/2021/5599654.

Garcia-Yi J. 2014. Market-based instruments for the conservation of underutilized crops: In-store experimental auction of native chili products in Bolivia. Sustainability 6 (11): 7768-7786. DOI: 10.3390/su6117768.

Gardjito M, Pridia H, Millaty M. 2024. Kuliner Sunda Nikmat Sedap Melegenda. UGM Press, Yogyakarta. [Indonesian]

Güler MC, Tanyeli A, Eraslan E, Bozhüyük MR, Ekinci Akdemir FN, Toktay E, Kurt N, Güven EÇ, Özkan G. 2021. Persimmon (*Diospyros kaki* L.) alleviates ethanol-induced gastric ulcer in rats. South Clin Istanb Eurasia 32 (1): 1-7. DOI: 10.14744/scie.2020.94546.

Habiba U, Bhomwick P, Khatun R, Seal R, Ghosh I, Karmakar A, Mandal D. 2025. Exploring the beneficial effect and therapeutic mechanism of phytochemicals present in *Selenicereus undatus* against hypertension based on molecular docking studies. J Drug Deliv Therapeut 15 (9): 27-39. DOI: 10.22270/jddt.v15i9.7348.

Hapsari L, Kennedy J, Lestari DA, Masrum A, Lestarini W. 2017. Ethnobotanical survey of bananas (Musaceae) in six districts of East Java, Indonesia. Biodiversitas 18 (1): 160-174. DOI: 10.13057/biodiv/d180123.

Hapsari L, Lestari DA, Masrum A. 2015. Album koleksi pisang Kebun Raya Purwodadi seri 1: 2010-2015. Purwodadi, Unit Pelaksana Teknis Balai Konservasi Tumbuhan, Kebun Raya Purwodadi–LIPI. 2015. [Indonesian]

Hilonga S, Otieno JN, Ghorbani A, Pereus D, Kocyan A, de Boer H. 2019. Trade of wild-harvested medicinal plant species in local markets of Tanzania and its implications for conservation. S Afr J Bot 122: 214-224. DOI: 10.1016/j.sajb.2018.08.012.

Hou S, Huang P, Yao Z. 2024. Ethnobotany study on wild edible plants used by the Tujia ethnic group in Laifeng, southwest Hubei, China. J Ethnobiol Ethnomed 20 (1): 94. DOI: 10.1186/s13002-024-00735-3.

Huang M, Duan R, Wang S, Wang Z, Fan W. 2016. Species presence frequency and diversity in different patch types along an altitudinal gradient: *Larix chinensis* Beissn in Qinling Mountains (China). PeerJ 4: e1803. DOI: 10.7717/peerj.1803.

Hughes AC. 2017. Understanding the Drivers of Southeast Asian Biodiversity Loss. Ecosphere 8 (1): e01624. DOI: 10.1002/ecs2.1624.

Husodo T, Annisa, Hadikusumah HY. Nurzaman M, Setiawati T, Kusmoro J. Mutaqin AZ, Karyono, Malik AD. 2018. Diversity of neglected and underutilized crop species (NUCS) at Rancabuaya, South Garut, West Java: Potentially as human food. Biodivers Intl J 2 (4): 322-329. DOI: 10.15406/bij.2018.02.00081.

Igwe DO, Ihearahu OC, Osano AA, Acquah G, Ude GN. 2021. Genetic diversity and population assessment of *Musa* L. (*Musaceae*) employing CDDP markers. Plant Mol Biol Rep 39: 801-820. DOI: 10.1007/s11105-021-01290-x.

Ihsan M, Irawan B, Iskandar J. 2024. The traditional ecological knowledge of the local people of Cijambu Village, Sumedang, Indonesia, on the diversity, utilization, management, and conservation of bamboo. Biodiversitas 25 (4): 1754-1770. DOI: 10.13057/biodiv/d250446.

Iketani H. 2016. Native fruit genetic tree in Japan. Breed Sci 66 (1): 82-89. DOI: 10.1270/jsbbs.66.82.

Irawan B, Safira KM, Annisa, Rohmatullayaly EN, Ihsan M, Suryana, Iskandar J, Iskandar BS. 2024. Ethnobotany of cassava (*Manihot esculenta*) in the traditional peri-urban Sundanese community of Cireundeu Hamlet, Cimahi City, West Java, Indonesia. Biodiversitas 25 (1): 116-128. DOI: 10.13057/biodiv/d250113.

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

Iskandar BS, Iskandar J, Irawan B, Partasasmita R. 2018a. Traditional markets and diversity of edible plant trading: Case study in Ujung Berung, Bandung, West Java, Indonesia. Biodiversitas 19 (2): 437-452. DOI: 10.13057/biodiv/d190211.

Iskandar BS, Iskandar J, Mulyanto D, Alfian RL, Suroso. 2021. Traditional market, social relations, and diversity of edible plants traded in Beringharjo Market, Yogyakarta, Indonesia. Biodiversitas 22 (4): 2045-2057. DOI: 10.13057/biodiv/d220453.

Iskandar BS, Iskandar J, Partasasmita R, Irawan B. 2020. Various medicinal plants traded in the village market of Karangwangi Village, Southern Cianjur, West Java, Indonesia. Biodiversitas 21 (9): 4440-4456. DOI: 10.13057/biodiv/d210963.

Iskandar BS, Iskandar J, Suroso, Alfian RA, Mulyanto D. 2022. Non-edible plants traded in traditional markets of Beringharjo, Yogyakarta and Pasar Baru, East Kalimantan, Indonesia: The role of biocultural system. Biodiversitas 23 (9): 4657-4669. DOI: 10.13057/biodiv/d230932.

Iskandar BS, Iskandar J, Wibawa HA, Partasasmita R. 2017. Farmers and tumpang sari: Case study in Palintang Hamlet, Cipanjalu Village, Bandung, Indonesia. Biodiversitas 18 (3): 1135-1149. DOI: 10.13057/biodiv/d180335.

Iskandar J, Iskandar BS, Partasasmita R. 2018c. Review: The impact of social and economic change on domesticated plant diversity with special reference to wet rice field and home-garden farming of West Java, Indonesia. Biodiversitas 19 (2): 565-577. DOI: 10.13057/biodiv/d190225.

Iskandar J, Kusmoro J, Mubarokah M, Partasasmita R. 2018b. Ethnobotany of banana plants (*Musa x paradisiaca*) of Palintang Hamlet, Cipanjalu Village, Bandung, West Java, Indonesia. Biodiversitas 19 (6): 2059-2072. DOI: 10.13057/biodiv/d190611.

Khoo HE, Azlan A, Kong KW, Ismail A. 2016. Phytochemicals and medicinal properties of indigenous tropical fruits with potential for commercial development. Evid Based Complement Alternat Med 2016: 7591951. DOI: 10.1155/2016/7591951.

Kulsum NNS, Susandarini R. 2023. Diversity of wild edible fruits in the agroforestry area of Cigalontang Village, Tasikmalaya, Indonesia. Biodiversitas 24 (7): 4161-4167. DOI: 10.13057/biodiv/d240755.

Kuswantoro F, Li' aini AS. 2021. Germination biology of the exotic ice cream bean (*Inga edulis* Mart.) seed from Bedugul, Bali. IOP Conf Ser: Earth Environ Sci 948: 012008. DOI: 10.1088/1755-1315/948/1/012008.

Lucius CR, Imanto T, Caroline, Roespinoedji D. 2021. Identification of old Javanese food in *Serat Chentini* through visual storytelling. Rigeo 11 (6): 1332-1339. DOI: 10.48047/rigeo.11.06.147.

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. J Ethnobiol Ethnomed 15 (1): 56. DOI: 10.1186/s13002-019-0336-x.

Mardiyanto MB, Foresty RS, Arlysia V, Choirunnisa ZFN, Nugroho GD, Yasa A, Naim DMD, Setyawan AD. 2023. Plants as herbal medicine at Nguter Traditional Market, Sukoharjo, Central Java, Indonesia. Asian J Ethnobiol 6 (1): 65-74. DOI: 10.13057/asianjethnobiol/y060108.

Marpaung AA, Fitmawati F, Nobis M. 2025. Wild plants in traditional markets of the Jakarta Metropolitan Area and their use in Indonesian culture: An ethnobotanical survey. Acta Soc Bot Pol 94: 1-19. DOI: 10.5586/asbp/203244.

Meena VS, Gora JS, Singh A, Ram C, Meena NK, Pratibha, Rouphael Y, Basile B, Kumar P. 2022. Underutilized fruit crops of Indian arid and semi-arid regions: Importance, conservation and utilization strategies. Horticulturae 8 (2): 171. DOI: 10.3390/horticulturae8020171.

Merrouni IA, Kharchoufa L, Bencheikh N, Elachouri M. 2021. Ethnobotanical profile of medicinal plants used by people of north-eastern Morocco: Cross-cultural and historical approach (part I). Ethnobot Res Appl 21: 1-45. DOI: 10.32859/era.21.34.1-45.

Ministry of Agriculture of the Republic of Indonesia. 2014. Indonesian Agricultural Genetic Resources of Food Crops, Agricultural Crops, and Horticultural Crops. IAARD Press, Jakarta [Indonesian]

Mukarromah AN, Dzihni A, Azzam AK, Adiningsih AR, Utami AS, Nazar IA, Sunarto, Iskandar J, Saensouk S, Setyawan AD. 2024. Ethnobotany of traditional rituals of Javanese in the city of Surakarta, Central Java, Indonesia. Asian J Ethnobiol 7 (1): 22-31. DOI: 10.13057/asianjethnobiol/y070103.

Mulyanto D, Iskandar J, Abdoellah OS, Iskandar BS, Riawanti S, Partasasmita R. 2018. *Leunca* (*Solanum americanum* Mill.): The uses as vegetable in two villages in Upper Citarum Area, Bandung, West Java, Indonesia. Biodiversitas 19 (5): 1941-1954. DOI: 10.13057/biodiv/d190546.

Nakintu J, Olet AE, Andama M, Lejju BJ. 2019. Ethno-varieties and distribution of jackfruit tree (*Artocarpus heterophyllus* Lam.) in Uganda: Implications for trade, food security and germplasm conservation. East Afr J Sci Technol Innov 1 (1): 27-51. DOI: 10.37425/eajsti.v1i1.66.

Nakum P, Singh B, Solanki H. 2025. The significance of seed banks: A review of techniques and technologies. Na J Adv Res Rev 25 (2): 2401-2407. DOI: 10.30574/wjarr.2025.25.2.0573.

Nanagulyan S, Zakaryan N, Kartashyan N, Piwowarczyk R, Łuczaj Ł. 2020. Wild plants and fungi sold in the markets of Yerevan (Armenia). J Ethnobiol Ethnomed 16 (1): 26. DOI: 10.1186/s13002-020-00375-3.

Navia ZI, Suwardi AB, Nuraini, Adnan, Baihaqi, Yakob M, Lubis P, Chairul. 2024. Diversity and ethnobotany of useful plants in Bandar Pusaka, Aceh Tamiang District, Indonesia. Ethnobot Res Appl 28: 1-26. DOI: 10.32859/era.28.35.1-26.

Nemogá GR, Appasamy A, Romanow CA. 2022. Protecting indigenous and local knowledge through a biocultural diversity framework. J Environ Dev 31 (3): 223-252. DOI: 10.1177/10704965221104781.

Ng KH, Maqbool M, Ong FS, Graf BA. 2017. Understanding underutilisation of locally grown tropical fruit and vegetables – why are imported apples preferred in Malaysia?. Proc Nutr Soc 76 (OCE4): E149. DOI: 10.1017/S0029665117003111.

Nguyen TS, Xia NH, Chu TV, Sam HV. 2019. Ethnobotanical study on medicinal plants in traditional markets of Son La Province, Vietnam. Forest and Society 3 (2): 171-192. DOI: 10.24259/fs.v3i2.6005.

Nuraeni S, Supangkat B, Iskandar J. 2022. Kajian etnobotani tanaman rempah sebagai bumbu, obat dan kias. UMBARA Indonesian Journal of Anthropology 7 (1): 27-38. DOI: 10.24198/umbara.v7i1.39395 [Indonesian]

Nursamsu, Nuraini, Sarjani TM, Mardudi. 2024. The use of medicinal plants in the Aneuk Jamee tribe in Kota Bahagia, South Aceh District, Indonesia. Biodiversitas 25 (6): 2524-2540. DOI: 10.13057/biodiv/d250622.

Offringa LC, Stanton MV, Hauser ME, Gardner CD. 2019. Fruits and vegetables versus vegetables and fruits: Rhyme and reason for word order in health messages. Am J Lifestyle Med 13 (3): 223-234. DOI: 10.1177/1559827618769605.

Penidda EI, Jumari, Baskoro K, Sahroni D, Peniwidiyanti, Sujarwo W. 2024. The local community understanding of the factors influencing the decline of *Saninten* (*Castanopsis argentea* (Blume) A.DC.) and *Tungurut* (*Castanopsis tungurrut* (Blume) A.DC.) in the buffer villages of the Gunung Halimun-Salak National Park. Reinwardtia 23 (1): 15-32. DOI: 10.55981/reinwardtia.2024.4710.

Poerba YS, Martanti D, Ahmad F, Herlina, Handayani T, Witjaksono. 2018. Deskripsi Pisang Koleksi Pusat Penelitian Biologi LIPI. LIPI Press, Jakarta. [Indonesian]

Pradhan SP, Chaudhary RP, Sigdel S, Pandey BP. 2020. Ethnobotanical knowledge of Khandadevi and Gokulganga Rural Municipality of Ramechhap District of Nepal. Ethnobot Res Appl 20: 1-32. DOI: 10.32859/era.20.07.1-32.

Pratama MF, Dwiartama A, Rosleine D, Abdulharis R, Irsyam ASD. 2019. Documentation of Underutilized Fruit Trees (UFTs) across indigenous communities in West Java, Indonesia. Biodiversitas 20 (9): 2603-2611. DOI: 10.13057/biodiv/d200924.

Pratiwi A, Lestari A, Romdhonah Y. 2022. Short communication: Germination monitoring of selected *Annonaceae* seeds: Seed bank collections of Purwodadi Botanic Garden, East Java, Indonesia. Biodiversitas 23 (7): 3567-3572. DOI: 10.13057/biodiv/d230733.

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. J Ethnobiol Ethnomed 20 (1): 68. DOI: 10.1186/s13002-024-00710-y.

Saensouk P, Saensouk S, Boonma T, Ragsasilp A, Junsongduang A, Chanthavongsa K, Jitpromma T. 2025a. Plant species diversity and the interconnection of ritual beliefs and local horticulture in *Heet Sip Song* ceremonies, Roi Et Province, Northeastern Thailand. Holticulturae 11 (6): 677. DOI: 10.3390/horticulturae11060677.

Saensouk P, Saensouk S, Hein KZ, Apparamaka S, Maknoi C, Souladeth P, Koompoot K, Sonthongphitak P, Boonma T, Jitpromma T. 2025b. Diversity, ethnobotany, and horticultural potential of local vegetables in Chai Chumphol Temple community Market, Maha Sarakham Province, Thailand. Holticulturae 11 (3): 243. DOI: 10.3390/horticulturae11030243.

Safitri NR, Hanum U, Pratiwi VMR, Hermawan WG, Nurcahyati M, Budiharta S, Setyawan AD. 2025. Ethnobotanical knowledge of edible plants in a karst landscape of Gawang Hamlet, Ketro Village, Pacitan District, Indonesia. Intl J Trop Drylands 9 (1): 85-97. DOI: 10.13057/tropdrylands/t090108.

Sagitarian DGF, Astikasari L, Rahmayani D, Armando MF, Nugroho GD, Himawan W, Mutaqin AZ, Setyawan AD. 2023. Biodiversity of edible fruit sold at Pasar Gede, Surakarta City, Central Java, Indonesia. Asian J Ethnobiol 7 (1): 57-68. DOI: 10.13057/asianjagric/g070108.

Santhyami, Laraswati, Agustina L, Agustina P. 2024. Exploring urban ethnobotany: A case study of medicinal plants traded in Gede Hardjonagoro Market, Surakarta, Indonesia. Trop J Nat Prod Res 8 (4): 6839-6851. DOI: 10.26538/tjnpr/v8i4.13.

Scavuzzo A, Arcari B, Magarini A, Gavazzini F, Duraccio S, Cagnola F. 2024. Wholesale Market: Public Spaces for Interconnected Food Policies. MUFPP, Milan.

Semenya SS, Maronyi A. 2020. Assessment of useful alien plant species cultivated and managed in rural home gardens of Limpopo Province, South Africa. Scientifica (Cairo) 2020: 3561306. DOI: 10.1155/2020/3561306.

Shuaib M, Ahmed S, Ali K, Ilyas M, Hussain F, Urooj Z, Shah SS, Kumar T, Shah M, Khan I, Hussain F. 2019. Ethnobotanical and ecological assessment of plant resources at District Dir, Tehsil Timergara, Khyber Pakhtunkhwa, Pakistan. Acta Ecol Sin 2018. DOI: 10.1016/j.chnaes.2018.04.006.

Suhaili ALR, Tennakoon K, Sukri RS. 2015. Soil seed bank of an exotic *Acacia* sp. plantation and an adjacent tropical heath forest in Brunei Darussalam. BIOTROPIA 22 (2): 140-150. DOI: 10.11598/btb.2015.22.2.487.

Sulistiyowati E, Setiadi, Haryono E. 2022. Food traditions and biodiversity conservation of the Javanese Community in Gunungkidul Karst, Yogyakarta Province, Indonesia. Biodiversitas 23 (4): 2080-2092. DOI: 10.13057/biodiv/d230443.

Sumarto, Aprianty D, Bachtiar RA, Kristiana L. 2018. Organoleptic characteristics and nutritive value estimation of baked food products from Manonjaya variety salacca flour. IOP Conf Ser: Earth Environ Sci 102: 012018. DOI: 10.1088/1755-1315/102/1/012018.

Suravanichnirachorn W, Haruthaithanasan V, Suwonsichon S, Sukatta U, Maneeboon T, Chantapornchai W. 2018. Effect of carrier type and concentration on the properties, anthocyanins and antioxidant activity of freeze-dried mao (*Antidesma bunius* (L.) Spreng) powders. Agric Nat Resour 52 (4): 354-360. DOI: 10.1016/j.anres.2018.09.011.

Susiarti S, Arifa N, Napisatinnaqiah E. 2021. Medicinal plant diversity in the market of Cibinong and Ciluar, Bogor. J Trop Ethnobiol 4 (1): 33-48. DOI: 10.46359/jte.v4i1.56.

Susiarti S, Rahayu M, Kuncari ES, Astuti IP. 2020. Utilization of "Benda" (*Artocarpus elasticus* Reinw. ex Blume) in Bogor, West Java, Indonesia: An ethnobotanical case study. J Trop Ethnobiol Conserv 17: 297-307. DOI: 10.51200/jtbc.v17i.2670.

Suwardi AB, Navia ZI, Mubarak A, Rahmat R, Christhy P, Wibowo SG, Irawan H. 2024. The diversity and traditional use of home garden plants near Kerinci Seblat National Park, Indonesia. Biodiversitas 25 (7): 3284-3299. DOI: 10.13057/biodiv/d250750.

Suwardi AB, Syamsuardi, Mukhtar E, Nurainas. 2023. The diversity and traditional knowledge of wild edible fruits in Bengkulu, Indonesia. Ethnobot Res Appl 25 (15): 1-17. DOI: 10.32859/era.25.15.1-17.

Tahir M, Abrahim A, Beyene T, Dinsa G, Guluma T, Alemneh Y, Van Damme P, Geletu US, Mohammed A. 2023. The traditional use of wild edible plants in pastoral and agro-pastoral communities of Mieso District, eastern Ethiopia. Trop Med Health 51 (1): 10. DOI: 10.1186/s41182-023-00505-z.

Tamang JP, Thapa N, Bhalla TC, Savitri. 2016. Ethnic fermented foods and beverages of India. In: Tamang JP (eds). Ethnic Fermented Foods and Alcoholic Beverages of Asia. Springer Nature, Berlin. DOI: 10.1007/978-81-322-2800-4_2.

Thakur AK, Kumar R, Verma RK. 2020. Abundance, frequency and distribution pattern of tree species in recorded forest area of Western Himalaya. Not Sci Biol 12 (2): 341-355. DOI: 10.15835/nsb12210620.

Torrecillas A, Corell M, Galindo A, Pérez-López D, Memmi H, Rodríguez P, Cruz ZN, Centeno A, Intrigliolo DS, Moriana A. 2018. Agronomical effects of deficit irrigation in apricot, peach, and plum trees. In: Tejero IFG, Zuazo VHD (eds). Water Scarcity and Sustainable Agriculture in Semiarid Environment: Tools, Strategies and Challenges for Woody Crops. Academic Press, Cambridge. DOI: 10.1016/B978-0-12-813164-0.00005-3.

Tsurayya DA, Saleh DA, Renaldi DR, Rizka DR, Widyaningyas R, Yasa A, Iskandar J, Saensouk S, Setyawan AD. 2025. Herbal medicines sold in Wonosobo Traditional Markets, Indonesia. Asian J Ethnobiol 8 (1): 13-25. DOI: 10.13057/asianjethnobiol/y080102.

Ueda Y, Higuchi H, Nawata E. 2016. Wild mangoes in North Thailand: An ethnobotanical study of local names and uses. Trop Agric Dev 60 (2): 93-102. DOI: 10.11248/jsta.60.93.

Ul Abidin SZ, Khan R, Ahmad M, Cuerrier A, Zafar M, Ullah A, Khan J, Saeed A, Al-Qahtani WH, Kazi M. 2024. Wild edible fruits as a source of food and medicine: A study among tribal communities of Southern Khyber Pakhtunkhwa. Plants 13 (1): 39. DOI: 10.3390/plants13010039.

Untari DT, Avenzora R, Darusman D, Prihatno J, Harnios A. 2017. Betawi traditional cuisines: Reflection the native culture of Jakarta (formerly known as Batavia). J Econ Dev Environ Ppl 6 (4): 64. DOI: 10.26458/jedep.v6i4.554.

Uro-Chukwu HC. 2024. Food culture, lifestyle & traditional food festivals: A narrative on the public health relevance of the traditional yam recipes in the Afikpo New Yam Festival. World Nutrit 15 (3): 66-79. DOI: 10.26596/wn.202415366-79.

Uzun SP, Koca S. 2020. Ethnobotanical survey of medicinal plants traded in herbal markets of Kahramanmaraş. Plant Divers 42 (6): 443-454. DOI: 10.1016/j.pld.2020.12.003.

Wongwaiwech D, Kamchonemenukool S, Ho CT, Li S, Thongsook T, Majai N, Premjet D, Sujipuli K, Weerawatanakorn M. 2022. Nutraceutical difference between two popular thai Namwa cultivars used for sun dried banana products. Molecules 27 (17): 5675. DOI: 10.3390/molecules27175675.

Yuningsih L, Hermansyah, Ibrahim E, Marsi. 2021. Diversity, structure and composition of vegetation in post-coal mining reclamation area in Sumatra, Indonesia. Biodiversitas 22 (8): 3392-3400. DOI: 10.13057/biodiv/d220836.

Zhang Y, Li JW, San MM, Whitney CW, San TT, Yang XF, Mon AM, Hein PP. 2020. The secret of health in daily cuisine: Typical healthy vegetables in local markets in central Myanmar. J Ethnobiol Ethnomed 16 (1): 73. DOI: 10.1186/s13002-020-00425-w.

Zierer W, Rüscher D, Sonnewald U, Sonnewald S. 2021. Tuber and tuberous root development. Ann Rev Plant Biol 72: 551-580. DOI: 10.1146/annurev-arplant-080720- 084456.