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IMPORTANCE AND LOCAL CONSERVATION OF WILD EDIBLE FRUIT PLANTS IN THE EAST ACEH REGION, INDONESIA

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Abstract

Wild edible fruits provide most of the nutrition and serve as a source of income for rural communities. This study aims to investigate the importance of wild edible fruit and the local conservation effort of the rural people in the East Aceh region, Indonesia. This study was carried out in eight villages of the Serbajadi sub-district. A semi-structured survey questionnaire with a free list approach was conducted involving 180 people (20 individuals from each of the villages), which were selected through simple random sampling. The components of the edible fruits were analyzed for their moisture, ash, fat, protein, carbohydrate, crude fiber, vitamin C, and minerals (Ca, P, Mg, Fe, K, and Na). In the investigation area, 46 wild edible fruit plants were found, representing 32 genera and 24 families. Mangifera odorata, Mangifera foetida, Durio oxleyanus, Pomea pinnata, Sandoricum koetjape, Baccaurea polyneura, Durio lowianus, Bischofia javanica, Artocarpus integer, Baccaurea brevipes, Flacuortia rukam, Mangifera caesia, Syzygium cumini, Baccaurea macrocarpa, and Garcinia xanthochymus were the most preferred respondents, which have economic value. These species have a nutritional value that is beneficial to human health. Along with revealing the enormous potential for plant breeding, WEFs are essential for livelihoods.

Keywords*: Diversity; Economics; Food; Wild edible fruit; Serbojadi; East Aceh*

Introduction

Biodiversity is of great importance in ensuring the different daily necessities [1, 2]. Since ancient times, people have been gathering plant resources to meet various daily needs. Wild edible fruit plants (WEFs) as one of the wild plant resources have played a crucial role in improving nutritional security across developing countries [3], especially the nutritional value [4]. Furthermore, it contains vitamins and minerals that are necessary for the maintenance of human health [5], as well as important sources of traditional beverages, food recipes, medicines, feed, firewood, building materials, and ritual material [6-9]. In addition, they are very essential for the livelihoods of local people in this region, not only as a source of food supplements, balanced nutrition, medicines, feed, and fuel but also for the development of resource management strategies, which may be essential for the conservation of several indigenous species [10, 11]. Rural communities in the East Aceh region, therefore, use multiple products from forests to sustain livelihoods, such as food supplies, cash for the purchase of goods and

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services, and savings for future needs [12]. Sales of WEFs by local people in Central Aceh, Indonesia, contributed 43% of the total annual household income from WEFs sold [10], while the communities in Aceh Tamiang earned 34.31% [11]. Indeed, WEFs are considered essential to sustain rural livelihoods, reduce the rate of poverty, and improve economic growth [13, 14]. However, human activities, such as changes in land-use, including the expansion of the agricultural sector, leading to deforestation, have also resulted in the loss of WEFs diversity [15], even in the East Aceh region. The loss of various species, especially WEFs leads to an increase in food insecurity [16]. Therefore, this study aims to investigate the importance of wild edible fruit and the local conservation effort of the rural people in the East Aceh region, Indonesia.

Materials and methods

Study area

This study was carried out in eight villages of Serbajadi sub-district (4°37'42.3"N, 97°24'00.6"E, 1250m a.s.l.), East Aceh, Indonesia including Lokop, Nalon, Jering, Selemak, Mesir, Leles, Terujak, and Tualang villages (Fig. 1). These villages are situated adjacent to the Serbojadi Nature Reserve.

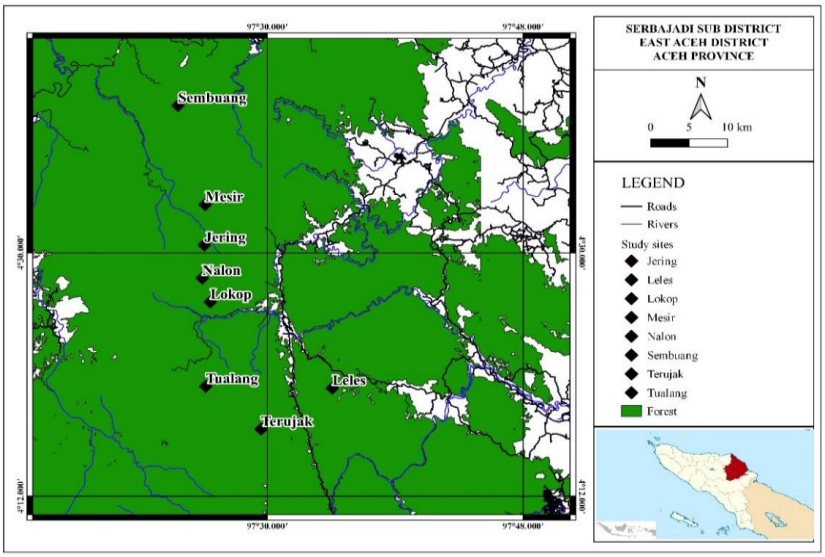

Fig. 1. Map of Serbajadi sub-district showed study area

These areas have a tropical humid climate with a dry season predominantly occurring from January to July while the rainy season runs from August to December. The rainfall ranges between 1,082 and 2,409mm per year with 113 - 160 rainy days. The average temperature is about 20.1ºC, while April and May are the hottest months at 26.6ºC while September remains the coldest with 19.7ºC with an average humidity of 80.08%. The topography is generally mountainous and hilly, and the zone is characterised by a cropping system in which rice and vegetables are the primary crops [17].

Data collection

A semi-structured survey questionnaire with a free list approach was conducted involving 160 people (20 individuals from each of the villages), which were selected using simple random sampling, with varying basic socio-demographic factors such as age, age group, education, and marital status (Table 1). The interviews were conducted face to face and lasted between 20 and 30 minutes, and a semi-structured questionnaire including vernacular names, uses, parts use, and economic value was used.

Table 1. Socio-demographic of respondents

Variable	Alternatives	Total (N = 160)	Percentage (%)
Sex	Male	68	42.5
	Female	92	57.5
Age	20-30	28	17.5
	31-40	42	26.3
	41-50	52	32.5
	51-60	24	15.0
	>60	14	8.8
Education status	Elementary School	66	41.3
	Secondary school	59	36.9
	High School	24	15.0
	University	11	6.9
Marital status	Single	34	21.3
	Married	118	73.8
	Widowed	8	5.0

The plant specimens from WEFs were collected according to the standard taxonomical procedures. The plant species were identified at the ANDA Herbarium of Andalas University in West Sumatra, Indonesia. The plant names have been updated on the World online website (*http://www.plantsoftheworldonline.org*). Plant specimens we're not deposited into the herbarium in this study.

Chemical analysis

The edible fruit components were analyzed for their moisture, ash, crude fiber, fat, protein, and mineral content (Ca, P, Mg, Fe, K, and Na). Moisture and ash were determined by oven drying and dry ash methods, respectively. The nitrogen content was determined by using the Kjeldahl method and multiplied by a factor of 6.25 to produce a crude protein [18]. The carbohydrates content was determined according to the following formula: Carbohydrate (%) = 100 - (percentage of ash + percentage of protein + percentage of crude fat + percentage of crude fiber) [19]. The nutritive value was determined by multiplying protein, fat, and carbohydrate content by 17, 37, and 16, respectively [20]. Furthermore, the crude fiber content was determined according to the standard methods of the AOAC [19]. The Vitamin C content present in the fresh fruit was determined by the iodine titration method [21]. Phosphorus was measured using the ammonium molybdate method. Ca, Fe, K, and Na were determined using the spectrophotometer atomic absorption (SAA) [22, 23].

Data analysis

The Relative Frequency Citation (RFC) showing the local importance of each species, as RFC = FC/N, where FC is the number of informants mentioning the use of the species, while N represents the total number of informants who took part in the study [24]. Chi-square (χ_2) was used to test the null hypothesis that there is no difference in the use of wild edible fruit plants under various use categories among the study villages. The correlation between the age of individuals and the number of citations of WEFs was calculated using the Spearman correlation test [25], while the Mann–Whitney test [26] was applied to find out the variation in plant citations by men and women informants. All of the analyses related to statistics were performed using SPSS 16.

Results and discussion

Diversity and patterns of use

The study area is floristically rich and includes various useful WEP species. In the investigation area, 46 wild edible fruit plants were found, representing 32 genera and 24 families. The Phyllantaceae was recorded as the highest number of species (6 species) or 13.04%, followed by Anacardiaceae, which contributed to being five species (10.87%), Euphorbiaceae, Sapindaceae, and Myrtaceae were the third in species diversity by having three species each (6.52%). Clusiaceae, Ebenaceae, Elaeocarpaceae, Malvaceae, and Moraceae

contributed two species each (4.35%), and fifteen of the remaining families were represented by single species (2.17%).

In the study area, local communities consume 44 (95.65%) WEFs as food. Fruits were the most common edible plant parts (93.48%), while leaves (4.35%) and stems (2.17%) were the remaining edible parts (Table 2).

Tabel 2. Wild edible fruit plants used as a food

Botanical Name	Family	Vernacular name	Part use	Use	RFC
Artocarpus elasticus Reinw. ex Blume	Moraceae	Terap	Seed	The seed is roasting as a snack	0.06
Artocarpus integer (Thunb.) Merr.	Moraceae	Cempedak	Fruit	The fruit is consumed raw, while the fresh form are used as vegetables	0.98
Baccaurea brevipes Hook.f.	Phyllantaceae	Tampoi	Fruit	The fruit is consumed raw	0.98
Baccaurea costulata (Miq) Mull. Arg	Phyllantaceae	Tampoi	Fruit	The fruit is consumed raw	0.62
Baccaurea macrocarpa (Miq.) Müll.Arg.	Phyllantaceae	Lara	Fruit	The fruit is consumed raw	0.92
Baccaurea sumatrana (Miq.) Müll.Arg.	Phyllantaceae	Tampoi	Fruit	The fruit is consumed raw	0.36
Baccaurea polyneura Hook.f.	Phyllantaceae	Jentik	Fruit	The fruit is consumed raw	0.98
Bischofia javanica Blume	Phyllantaceae	Tingkeum	Fruit	The fruit is consumed raw	0.98
Blumeodendron tokbrai (Blume) Kurz	Euphorbiaceae	Bantas gunung	Fruit	The fruit is consumed raw	0.18
Bouea oppositifolia (Roxb.) Meisn.	Anacardiaceae	Raman hutan	Fruit	The fruit is consumed raw	0.22
Dacryodes rostrata (Bl.) H.J. Lam	Burseraceae	Asem duku	Fruit	The fruit is consumed raw	0.06
Dalrympelea sphaerocarpa (Hassk.) Nor-Ezzaw.	Staphyleaceae	Selekop	Fruit	The fruit is consumed raw	0.02
Dillenia indica L.	Dilleniaceae	Simpur	Fruit	The fruit is consumed raw	0.15
Diospyros macrophylla Blume	Ebenaceae	Siamang	Fruit	The fruit is consumed raw	0.17
Diospyros areolata King & Gamble	Ebenaceae	Kayu malam	Fruit	The fruit is consumed raw	0.13
Durio lowianus Scort. ex King	Malvaceae	Durian hutan	Fruit	The fruit is consumed raw	0.98
Durio oxleyanus Griff.	Malvaceae	Durian Daun	Fruit	The fruit is consumed raw	0.98
Elaeocarpus acronodia Mast.	Elaeocarpaceae	Not Known	Fruit	The fruit is consumed raw	0.06
Elaeocarpus floribundus Blume	Elaeocarpaceae	Kemesu	Fruit	The fruit is consumed raw	0.10
Elateriospermum tapos Blume	Euphorbiaceae	Tapos	Seed	The seed is roasting as a snack	0.09
Ficus lepicarpa Blume	Myrtaceae	Ara	Fruit	The fruit is consumed raw	0.07
Flacourtia rukam Zoll. & Moritzi	Salicaceae	Rukam	Fruit	The fruit is consumed raw	0.98
Garcinia xanthochymus Hook.f. ex	Clusiaceae	Asam gelugur	Fruit	The fruit is consumed raw	0.98
Garcinia nigrolineata Planch. ex T.Anderson	Clusiaceae	Manggis hutan	Fruit	The fruit is consumed raw	0.62
Knema furfuracea (Hook f. & Thomson) Warb	Myristicaceae	Pala hutan	Fruit	The fruit is consumed as spices	0.58
Lepisanthes amoena (Hassk.) Leenh.	Sapindaceae	Kalansua	Fruit	The fruit is consumed raw	0.06
Lithocarpus indutus (Blume) Rehder	Fagaceae	Balik angin	Seed	The seed is roasting as a snack	0.26
Litsea cubeba (Lour.) Pers.	Lauraceae	Medang	Fruit	The fruit is eaten as vegetables	0.44
Mallotus philippensis (Lam.) Müll.Arg.	Euphorbiaceae	Kamala	Fruit	The fruit is consumed raw	0.46
Mangifera caesia Jack.	Anacardiaceae	Binjai	Fruit	The fruit is consumed raw	0.98
Mangifera foetida Lour.	Anacardiaceae	Bachang	Fruit	The fruit is consumed raw	0.98
Mangifera odorata Griff.	Anacardiaceae	Kuweni	Fruit	The fruit is consumed raw	0.98
Micromelum minutum (G.Forst.) Wight & Arn.	Rutaceae	Temereu hutan	Leaves	The leave is used as a spice	0.48
Musa balbisiana Colla	Musaceae	Pisang hutan	Stem	The stem is used as a vegetable	0.13
Passiflora foetida L.	Passifloraceae	Asang-asang	Fruit	The fruit is consumed raw	0.70
Physalis angulata L.	Solanaceae	Ciplukan	Fruit	The fruit is consumed raw	0.76
Planchonia valida (Blume) Blume	Lecythidaceae	Not Known	Leaves	Young leaves are eaten as vegetables	0.15
Pometia pinnata J.R.Forst. & G.Forst.	Sapindaceae	Keulayu	Fruit	The fruit is consumed raw	0.98
Prunus arborea (Blume) Kalkman	Rosaceae	Moyang	Fruit	The fruit is consumed raw	0.02
Sandoricum koetjape (Burm.f.) Merr.	Meliaceae	Setui	Fruit	The fruit is consumed raw	0.98
Spondias mombin L.	Anacardiaceae	Kedondong hutan	Fruit	The fruit is consumed raw	0.61
Syzygium cumini (L.) Skeels	Myrtaceae	Jambu keling	Fruit	The fruit is consumed raw	0.98
Syzygium nervosum A.Cunn. ex DC.	Myrtaceae	Salam	Leaves	The leave is used as a spice	0.71
Xerospermum noronhianum (Blume) Blume	Sapindaceae	Rambutan hutan	Fruit	The fruit is consumed raw	0.58

The fruit was the dominant part of wild edible plants that were reported to be highly edible. This study is in line with the majority of studies conducted in different regions of Indonesia [8, 14, 27]. The use of fruit in comparison with other parts of the plant may be due to its good taste and flavour as well as its nutritional composition. Based on RFC values, a total of fifteen (15) species of WEFs have maximum RFC (0.98 or 98%), such as *Artocarpus integer, Baccaurea brevipes, Baccaurea macrocarpa, Baccaurea polyneura, Bischofia javanica, Durio lowianus, Durio oxleyanus, Flacuortia rukam, Garcinia xanthochymus, Mangifera caesia, Mangifera foetida, Mangifera odorata, Pometia pinnata, Sandoricum koetjape,* and *Syzygium cumini*. Furthermore, WEFs with high RFC indicates that the species is recognised by respondents and is frequently used. Instead, a total of 21 (45.65%) WEFs had a low RFC (<0.5 or <50%) indicating that these species are rarely consumed by local populations in the area, such as *Dalrympelea sphaerocarpa*, *Prunus arborea*, and *Elaeocarpus floribundus*.

WEFs are a great source of vitamins, carbohydrates, proteins, fiber, and minerals that complement the diets of the rural community. Furthermore, it has become a very essential part of human nutrition and therefore cannot be neglected in terms of food security and good health. Tables 3 and 4 show the approximate composition and mineral content of the most preferred WEFs in the study area, respectively.

Table 3. Nutrition value of the most preferred wild edible fruit plants in the study area (g/100g fresh weight)

Botanical Name	Moisture	Ash	Crude protein	Crude fat	Crude Fibre	Available Carbohydrate	Vitamin C	Nutritive value (kcal/100g)
Artocarpus integer	73.8±0.3	1.8±0.1	1.5±0.3	0.8±0.1	3.9±0.4	93.8±0.4	14.7±1.2	388.4±0.4
Baccaurea brevipes	77.5±0.7	2.8±0.2	1.3±0.2	0.2±0.3	4.3±0.4	94.2±0.6	4.3±0.6	383.8±0.2
Baccaurea macrocarpa	82.2 ±0.4	3.1±0.4	2.1±0.3	0.9±0.1	3.9±0.2	93.1±0.8	2.4±0.2	388.9±0.2
Baccaurea polyneura	81.4 ±0.1	3.9±0.2	3.5±0.1	0.9±0.1	3.6±0.1	92.0±0.6	2.8±0.1	390.1±0.1
Bischofia javanica	79.2 ±0.2	2.8±0.1	2.5±0.6	0.9±0.2	3.3±0.3	93.3±0.2	3.2±0.2	391.3±0.1
Durio lowianus	80.3 ±0.8	1.9±0.6	3.2±0.3	1.6±0.2	3.2±0.2	92.0±0.6	2.2±0.2	395.2±0.4
Durio oxleyanus	79.6 ±0.2	2.2±0.1	3.3±0.1	1.5±0.4	3.5±0.2	91.7±0.3	2.4±0.1	393.5±0.2
Flacuortia rukam	78.8 ±0.1	1.1±0.1	2.1±0.2	0.2±0.2	2.8±0.1	94.9±0.2	5.0±0.4	389.8±0.1
Garcinia xanthochymus	78.9 ±0.9	1.4±0.2	1.7±0.2	1.1±0.2	3.4±0.1	93.8±0.6	44.2±1.2	391.9±0.4
Mangifera caesia	78.4 ±0.6	2.8±0.3	2.1±0.1	1.5±0.2	6.2±0.8	90.2±0.2	31.9±0.8	382.7±0.2
Mangifera foetida	83.3 ±0.5	1.9±0.4	2.9±0.4	1.2±0.2	5.8±0.2	90.1±0.6	34.2±0.8	382.8±0.4
Mangifera odorata	76.4 ±0.4	1.2±0.2	2.4±0.2	1.2±0.3	5.4±0.2	91.0±0.4	38.8±1.2	384.4±0.1
Pometia pinnata	80.2 ±0.1	2.1±0.2	2.2±0.1	0.8±0.1	3.3±0.6	93.7±0.6	38.2±1.4	390.8±0.3
Sandoricum koetjape	85.8 ±0.3	1.8±0.2	4.1±0.1	0.2±0.2	3.6±0.3	92.1±0.6	14.1±0.6	386.6±0.2
Syzygium cumini	79.2 ±0.7	2.2±0.3	2.1±0.3	0.3±0.2	4.8±0.2	92.8±0.8	6.9±0.4	382.3±0.3

Each value in the table was obtained by calculating the average of three experiments and data are presented as Mean±SD

The stated nutritional value confirms that it contains high nutrients that can meet the recommended daily intake. For example, the nutritional value of *Durio lowianus* (395.2kcal/100g) contributed approximately 29.26% of the recommended daily intake (RDI) [28] for children (1 to 3 years of age). The vitamin C content of *Garcinia xanthochymus, Mangifera odorata*, *Pometia pinnata*, *Mangifera caesia*, and *Mangifera foetida* fruit per 100g edible portion was higher than other WEFs. This suggests that these WEFs can be a source of vitamin C for rural communities. Furthermore, vitamin C acts as a catalyst for chemical reactions that take place in the human body [29], also act as an antioxidant and plays an important role in protecting cells from oxidative damage caused by reactive oxygen species (ROS) [30, 31]. Compared to vitamin A and vitamin E, vitamin C has the highest antioxidant activity [32].

The close composition of several WEFs shows that the micronutrient content is comparable and higher than that of cultivated species. For example, the iron (Fe) content was present in the fruits of *Bischofia javanica* (2.3mg/100 g) (Table 5) and was higher than iron in cultivated fruit plants, such as *Malus domestica* Borkh. (0.66mg/100g), *Litchi chinensis* Sonn**.** (0.70mg/100 g), and *Carica papaya* L. (0.5mg/100 g) [33]. The consumption of WEFs, which are regularly examined in this work, is intended to prevent iron deficiency in pregnant women in study areas. Wild fruits have excellent potential in terms of essential nutrients, especially for growing children that are prone to malnutrition [34]. WEFs are consumed to supplement the

nutrition of staple foods, which is the solution to hunger due to a lack of a balanced diet [35] and contribute to food and nutrition security for the local people in rural areas.

Table 4. Mineral value of the most preferred wild edible plants collected from the study area

Botanical Name	P (mg)	K (mg)	Ca (mg)	Na (mg)	Fe (mg)
Artocarpus integer	30.2±11.18	322.9±12.41	20.0±11.20	2.3±0.08	1.6±0.81
Baccaurea brevipes	14.2±8.21	188.6±9.82	12.9±8.21	3.1±0.12	0.3±0.24
Baccaurea macrocarpa	54.3±12.02	293.2±11.11	10.0±6.36	1.6±0.06	0.9±0.11
Baccaurea polyneura	52.4±10.12	288.1±12.53	11.0±4.23	2.0±0.01	0.3±0.01
Bischofia javanica	11.0±8.32	189.6±14.08	14.0±8.08	0.1±0.01	2.3±0.21
Durio lowianus	12.0±8.02	128.5±12.02	3.0±1.11	0.9±0.05	1.0±0.01
Durio oxleyanus	13.0±6.44	160.1±6.24	3.2±0.26	1.9±0.06	1.7±0.42
Flacuortia rukam	12.3±11.02	198.2±14.21	2.7±0.31	0.8±0.05	1.2±0.11
Garcinia xanthochymus	19.0±12.04	183.1±8.14	63.0±11.08	2.0±0.11	1.6±0.25
Mangifera caesia	17.0±8.08	120.0±11.01	7.1±3.08	1.3±0.08	0.3±0.01
Mangifera foetida	19.0±12.61	360.8±12.05	16.1±4.21	2.0±0.06	0.2±0.02
Mangifera odorata	13.7±9.32	187.1±8.21	8.9±4.01	2.0±0.02	0.4±0.01
Pometia pinnata	12.3±11.11	188.3±9.61	60.1±6.02	0.9±0.02	1.2±0.14
Sandoricum koetjape	17.2±11.12	110.0±8.11	4.3±2.22	1.0±0.05	2.1±0.24
Syzygium cumini	15.8±12.44	116.0±9.08	8.4±4.30	2.1±0.12	1.6±0.28

Each value in the table was obtained by calculating the average of three experiments and data are presented as Mean±SD

Besides food value, 13 species (28.26%) are used as traditional medicine (Table 5). Most of the leaves are part of the plants used for therapy (61.54%), followed by fruits (30.77%), and seeds (7.69%). These medicinal remedies were used for coughs, hypertension, diarrhoea, dysentery, fever, stomach problems, obesity, stomach ulcers, wound, itch, swelling, gout, and skin diseases.

Medicinal plants were indeed used in the form of extracts or powders. Other preparation methods, such as *Garcinia xanthochymus*, included chewing fresh fruit. During the discussion, respondents said people sometimes add honey to plant extracts to reduce the bitter or unpleasant taste. In addition to adding flavor to the extract, honey is also believed to be beneficial to good health and has immunomodulatory capabilities [36], which reduce gastrointestinal complications [37] and have hepatoprotective and nephroprotective effects [38], that are important for human health. The method and dosage of herbal preparations depending on the characteristics of the disease. Several plants are boiled while others are applied directly in fresh form, and various medicinal plants, such as *Litsea cubeba* leaves, are pressed and applied directly to the swollen part of the body.

Table 5. Wild edible fruit plants used as traditional medicines

Botanical Name	**Family**	**Vernacular name**	**Part use**	**Diseases treated**
Dillenia indica	Dilleniaceae	Simpur	Leave	Coughs
Elateriospermum tapos	Euphorbiaceae	Tapos	Seed	Hypertension
Flacourtia rukam	Salicaceae	Rukam	Fruit	Diarrhoea and dysentery
Garcinia xanthochymus	Clusiaceae	Asam kandis	Fruit	Fever, coughs, stomach problems, and treatment of obesity
Lepisanthes amoena	Sapindaceae	Kalansua	Leave	Stomach ulcers
Litsea cubeba	Lauraceae	Medang	Leave	Wound, itch, and swelling
Musa balbisiana	Musaceae	Pisang hutan	Fruit	Gout, cough, dysentery
Micromelum minutum	Rutaceae	Temereu hutan	Leave	Fever
Passiflora foetida	Passifloraceae	Markisa hutan	Leave	Fever
Planchonia valida	Lecythidaceae	Not Known	Leave	Skin diseases
Syzygium cumini	Myrtaceae	Jambu keling	Fruit	Diarrhoea
Syzygium nervosum	Myrtaceae	Salam	Leave	Diarrhoea, itch
Voacanga foetida	Apocynaceae	Telur kambing	Leave	Wound, itch, and swelling

Wild plants, including WEFs, contains a wide range of secondary metabolic plant products such as polyphenols, terpenoids, and polysaccharides, making the species better candidates as nutraceuticals, i.e. functional foods [39]. Due to its rich sources of antioxidants

and fibrous components, wild fruits can cure several diseases such as diabetes, cardiovascular problems, inflammation, and digestive and urinary disorders [40]. Digestive symptoms, such as constipation, diarrhea, abdominal bloating, and pain have been reported to correlate to the various maladaptive behaviors and it is accepted that an important correlation exists between the physical exercise and the oxidative stress status, the data regarding the levels of the main oxidative stress markers [41, 42].

Overseas, approximately 64% of the total population of the world depends on traditional medicine for wellbeing [43]. Traditional knowledge on the use of the plant as a medicine has been passed down from generation to generation based on practical observation and experience [10]. Through the trials and errors experimentation of people struggling with health problems, such as the suffering from pains, illness, and serious injuries, the healing properties of plants have been created over time [44]. One of the main functions of the immunity system in neoplastic pathology consists in the detection and purging of new tumoral cells but also depending on the approach to the different other pathologies, the cure of various diseases or wounds can be obtained in a short time [45-48].

Other uses of WEFs in the study area were fodder, building material, and fuelwood. *Lithocarpus indutus*, one of the important timber forest products for building materials. The Chi-square ($\chi 2$) test ($\chi 2 = 2.08$; df = 28; a = 0.05 and 1-a = 41.34) revealed that the number of species reported to be used by the people of the five study villages did not differ significantly, meaning that these uses are common services obtained from WEFs in East Aceh region (Table 6).

Commercial value

Rural communities living around Serbojadi Nature Reserved are gathering WEFs to to trade in domestic markets, and some are sold along the roadside in villages. Most of the fruit came from the forest and farmland. The species, trade part, and the sale price of the WEFs sold to rural communities in the study areas are shown in Table 7.

Table 6. Comparison of percentage of the general utility of wild edible fruit plants among the eight study villages

Villages	Food	Medicinal	Building materials	Fodder	Fuelwood	Chi-Square
Lokop	36.7	12.2	4.2	7.8	6.3	$\chi 2 = 2.08^{ns}$
Nalon	38.5	11.6	3.8	7.2	6.7	
Jering	40.5	12.3	4.6	8.0	6.0	
Selemak	42.2	11.8	3.3	8.0	6.0	
Mesir	38.3	10.3	4.2	8.0	7.0	
Leles	37.6	12.3	4.0	7.1	6.4	
Terujak	36.3	12.8	3.8	7.2	7.0	
Tualang	38.7	11.2	4.0	7.6	7.0	

Table 7. Market values of wild edible fruit plants

Botanical name	Vernacular name	Family	Part trade	Price (IDR)
Artocarpus integer	Cempedak	Moraceae	Fruit	4,000±316
Baccaurea brevipes	Tampoi	Phyllantaceae	Fruit	4,000±592
Baccaurea polyneura	Jentik	Phyllantaceae	Fruit	11,000±447
Bischofia javanica	Tingkeum	Euphorbiaceae	Fruit	8,000±632
Bouea oppositifolia	Raman hutan	Anacardiaceae	Fruit	4,000±775
Durio lowianus	Durian hutan	Malvaceae	Fruit	8,000±632
Durio oxleyanus	Durian daun	Malvaceae	Fruit	9,000±447
Garcinia xanthochymus	Asam kandis	Clusiaceae	Fruit	7,000±447
Mangifera caesia	Binjai	Anacardiaceae	Fruit	8,000±316
Mangifera foetida	Bachang	Anacardiaceae	Fruit	8,000±592
Mangifera odorata	Kuweni	Anacardiaceae	Fruit	8,000±592
Pometia pinnata	Keulayu	Sapindaceae	Fruit	8,000±632
Sandoricum koetjape	Setui	Meliaceae	Fruit	10,000±775
Syzygium cumini	Jambu keling	Myrtaceae	Fruit	8,000±592

Most WEFs are important in improving life quality and achieve food security in remote communities surrounding the Serbojadi Nature Reserve. It is also recognized as a viable source of vitamins and minerals that are necessary for proper health maintenance [5] and for ensuring food security [49]. In addition, about 34% of all respondents sold WEFs, which have the potential to provide advantages and increase revenue. However, approximately 52 percent of all participants selling WEFs earn under 10,000,000 Indonesian Rupiah (IDR) per year (1 USD= 14,000 IDR at the time of the survey), while 48 percent receive between IDR 10,000,000 and 20,000,000 annually. The sales of WEFs contributed 22.4% of the total average annual household income of the people in the study area. This contribution is lower than reported in Riau, where the local community accounted for 38% of the total annual household income [50], in the Aceh Tamiang region (34.31%) [14], and Central Aceh, Indonesia (43%) [10].

Knowledge holders

Traditional knowledge could be used to support in-situ conservation (conservation in natural habitats). The mean plant species mentioned by each respondent age group varied from 18.6 ± 0.11 (31-40 years) to 60.30 ± 0.02 (> 60 years). The mean number of species recognised by each educational status varied from 16.8 ± 0.80 (Senior High School) to 38.11 ± 0.10 (Elementary School). It was discovered in this study that there were variations in the knowledge and use of WEFs between gender and age groups in the area. The Mann – Whitney statistical analysis results showed that women are more knowledgeable about WEFs than men ($P = 0.002$; $P < 0.05$; n = 125), and it proves that women play an important role in knowledge transfer. The analysis of Spearman's rank correlation between age and the number of WEFs citations (r = 0.643; $P < 0.001$) was significant for the individuals studied. It was noted that older people that were mostly undereducated, reported the highest number of uses of WEFs compared to younger respondents. Moreover, those >60 years old were much more knowledgeable about WEFs than other age groups, leading to more practical experience. This study reported that WEFs knowledge was obtained from parents and grandparents (62%), while 38% received it from formal education. Respondents indicated that parents, especially mothers, have always adopted and used the local WEFs name for the children. This study is in line with the research conducted in Aceh Tamiang district, Indonesia [8], which states that elders transfer knowledge to ensure that it is not lost across generations [51].

Local conservation strategies

The sustainable use of biodiversity is seen as extremely important and urgent, as this wealth is a growing threat of extinction and requires the attention of various parties. The sustainable use of WEFs is a smart solution and provides a useful framework for managing biological resources. The local community in the East Aceh region has local wisdom of protection and use of forest products, including WEFs. During the discussion, respondents state that communities living around the forest are harvesting timber for building materials. In practice, they're not cutting down trees that bear fruit. In addition, not all the fruit was harvested by the community during the fruiting season. They consider leaving sufficient fruit to feed animals such as monkeys or birds. This local wisdom contributes positively to the conservation of various animal and plant species, including WEFs, as an in-situ local conservation strategy.

Forty percent of respondents said that the main problem with the protection and promotion of WEFs is a change in the lifestyle of the local community, particularly young, who tend to prefer to consume imported fruit such as apples, grapes, or other superior genetically engineered fruits that have a better appearance and taste than local fruit, including WEFs. In addition, the increased conversion of forests to agricultural land in recent years is a threat to the sustainability of WEFs. However, the local community in the study area has undertaken conservation action to improve the availability of WEFs by planting several species on their orchids, home gardens, or farmlands. During the survey, a few individuals planted WEFs, such as *Durio oxleyanus* and *Garcinia xanthochymus*, in their farmland. They also plant WEFs, in particular those with economic value, on abandoned agricultural land bordering forests. This effort is aimed at maintaining the availability of fruits that can be harvested and sold for economic purposes.

Domestication of WEFs into orchids, home gardens, or farmlands can be used for ex-situ conservation strategies. Several of the WEFs documented in this study, such as *Baccaurea polyneura, Baccaurea brevipes, Flacuortia rukam, Durio lowianus,* and *Pometia pinnata,* may be important not only as food and nutrient sources for local communities but also as a source of income. WEFs could be used to overcome malnourishment and hunger, as well as to minimise the risks associated with overharvesting fruits [52]. This will not only increase the nutritional status and livelihood opportunities of local communities, but it will also conserve biodiversity from extinction [53]. The integration of trees in agricultural areas has a positive effect on the physical and chemical elements of the earth, which protects the land from erosion, improves the microenvironment, and provides firewood, fuelwood, and construction material to people in rural areas [54].

Conclusions

A total of 46 wild edible fruit plants representing 32 genera and 24 families were reported in the investigation area. *Mangifera odorata, Mangifera foetida, Durio oxleyanus, Pomea pinnata, Sandoricum koetjape, Baccaurea polyneura, Durio lowianus, Bischofia javanica, Artocarpus integer, Baccaurea brevipes, Flacuortia rukam, Mangifera caesia, Syzygium cumini, Baccaurea macrocarpa,* and *Garcinia xanthochymus* were the most preferred respondents, which have economic value. Our findings have shown that WEFs are not only food and nutrient sources for local communities, but also their medicinal properties and could be a means of generating income. Therefore, sustainable management of these resources is of the greatest importance for the livelihood of local communities as well as for biodiversity conservation, and the promotion of cultural and genetic resources.

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