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Research Article

WILD EDIBLE PLANTS IN ENHANCING POST-DISASTER FOOD SECURITY, ORMOC CITY, PHILIPPINES

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ARTICLE HIGLIGHTS

- In Ormoc City, Philippines, wild edible plants play a vital role in ensuring food security during disasters.
- Among these, *M. malabathricum* stands out for its richness in calcium, magnesium, and manganese, while *Diplazium esculentum* is notable for its high levels of iron, copper, and zinc.
- Additionally, wild fruits like *Melastoma malabathricum, Annona montana,* and *Rubus fraxinifolius* contribute significant Vitamin C to the diet.
- Collectively, these plants provide a diverse range of essential nutrients and offer local medicinal benefits, supporting both sustenance and health in the community.

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ABSTRACT

Wild Edible Plants (WEPs) are a valuable resource for communities facing food insecurity, and their nutritional profiles can provide essential dietary needs, especially in disaster-prone regions like the Philippines. This paper explores the nutritional value of wild edible plants (WEPs) in Ormoc City, Leyte, Philippines, with a particular focus on their role in addressing food security issues during natural disasters. The research included surveying the WEPs used by the local community in Ormoc City and analyzing these plants' nutrient and mineral composition. The study's key findings included identifying 15 plant species from 13 families. *Melastoma malabathricum* showed the highest Ca, Mg and Mn content; while *Diplazium esculentum* leaves had the highest iron, copper and zinc content. Furthermore, relatively high vitamin C content was found in wild fruits *M. malabathricum*, *Annona montana*, and *Rubus fraxinifolius.* The plants analyzed were rich in essential nutrients, including minerals (Ca, Na, Mg, Mn, Fe, Cu and Zn), crude fiber and vitamin C. The different plants excelled in different nutritional aspects, suggesting a diverse dietary potential. These plants play a crucial role in the local community, providing not only sustenance but also medicinal applications. Further research and conservation efforts should be encouraged to harness the nutritional and economic potential of these plants while ensuring their sustainable utilization and preservation.

Keywords: *Diplazium esculentum,* food alternative, *Melastoma malabathricum, Rubus fraxinifolius*

INTRODUCTION

Wild Edible Plants (WEPs) encompass non-cultivated plant species growing spontaneously in nature in their natural or semi-natural habitats, which are harvested from the wild and utilized as sources of sustenance (Demir *et al.* 2020; Duguma 2020; Mahklouf 2019). WEPs, which are a rich source of micronutrients (Talang *et al.* 2023) play a vital role as alternative food resources for families facing food insecurity in many developing and underdeveloped nations grappling with issues, such as poverty, famine, and drought (Anbessa *et al.* 2024; Mishra *et al.* 2021; Guzo *et al.* 2023; Ojelel *et al.* 2019). Many WEPs have nutritional profiles akin to those of cultivated crops like some of the common vegetables (Talang *et al.* 2024; Waheed *et al.* 2023), rendering them valuable in augmenting the essential dietary needs of rural communities (Nyakoojo & Tugume 2020; Ojelel *et al.* 2019).

The Philippines is a region frequently subjected to a range of natural disasters, and exposed to natural hazards (Asio 2020; Ipong *et al.* 2020; Yoshioka *et al.* 2021; Radtke *et al.* 2018). One example of this vulnerability occurred in 2013 when Typhoon Haiyan, one of the most powerful tropical cyclones ever recorded, severely impacted Ormoc City.

Subsequently, in 2017, a 6.5-magnitude earthquake struck the city (Ipong *et al.* 2020). Following the disaster, affected communities relied heavily on external aid. However, due to the extensive damage, especially in remote areas, relief operations were delayed. As assessed by Stumpf *et al.* (2014), food supply emerged as one of the critical challenges in the aftermath of Typhoon Haiyan. The nutritional evaluation of WEPs can establish options to achieve food and nutritional security (Talang *et al.* 2023), in response to Sustainable Development goal of zero hunger.

In the Philippines, a number of studies documenting wild edible plants in the country, and knowledge regarding their nutritional value has been conducted (Buenavista *et al.* 2022; Cacatian & Tabian 2023; Tasani & Barcellano 2024). This study was premised on several assumptions: 1) less attention is given to WEPs as a potential alternative to enhance food security for the community; 2) WEPs contain essential nutrients and minerals that can address nutritional requirements of the community during a disaster, hence the need to analyze their nutritional content, and 3) there is a need to incorporate information about WEPs into policies enhancing food security of a community during a disaster.

Consequently, this study (a) surveyed the WEPs already utilized by the local community, (b) assessed the nutrient and mineral composition of WEPs found in Ormoc City to ascertain their contribution to food security, and (c) identified potential implications for the utilization of WEPs during times of disaster.

MATERIALS AND METHODS

Study Area

Ormoc City has a total land area of 46,430 ha and is subdivided into 110 *barangays* (the smallest administrative division in the Philippines). Half of the lands is in mountainous and hilly areas, with agriculture, comprising 26,298 ha (56.64%), being the main use. The city has 15,034 ha (32.38%) of forest lands and 2,672 ha (5.75%) of commercial areas (Dumalan 2023). Ormoc City is located at 11°00'26.59" N, 124°36'28.46" E in an enclave fronting the Ormoc Bay. The ambient temperature of Ormoc City is 25.9 °C, relative humidity of 70.2%, wind speed 0.55 m/s at 104°, east (BP Integrated Technologies, Inc. 2019) and an average rainfall of 2,456 mm. Given its geographical location, Ormoc in general, is highly susceptible to natural hazards and extreme weather events.

Ormoc City's land encompasses a wide variety of plants, including wild edible plants that can serve as alternative food sources in the event of a calamity. Wild edible plants were collected from *Barangays* Bagong, Cabintan, Gaas, and Lake Danao, in Ormoc City, Leyte, Philippines (Fig. 1) in March 2019.

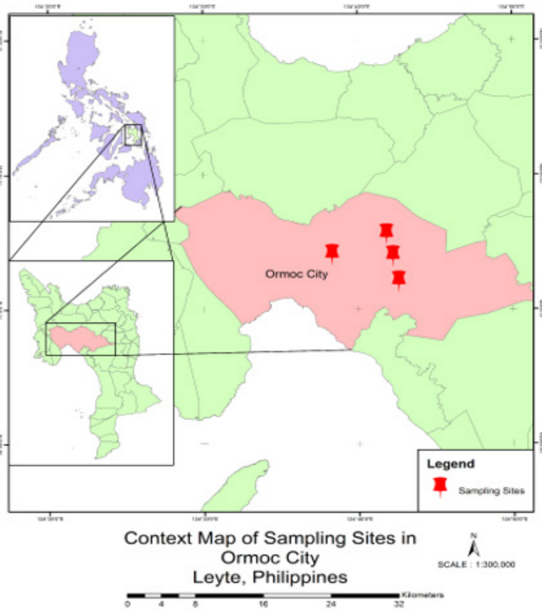

Figure 1 Context map of the study sites in Ormoc City, Leyte (Source: Central Visayas Center for Environmental Informatics (CENVI) 2019).

Data Collection

Permission to conduct the study was sought from the local government unit through the City Agriculture Office (CAO).

Qualitative Ethnobotanical Survey

A qualitative ethnobotanical survey was conducted in March 2019 through key informant (KI) interviews. The methods used in similar studies (Cacatian & Tabian 2023; Rahim *et al.* 2019; Nyakoojo & Tugume 2020) were employed. The *barangays* selected were based on anecdotal information (Tugume & Nyakoojo 2020) provided by some of the personnel of the City Agriculture Office. The City Agriculture Office of Ormoc purposively provided one key informant each for *Barangays* Bagong, Cabintan, Gaas, and Lake Danao based on their wide knowledge of the plant diversity in the study areas, and they provided folk knowledge of plants. Guided field excursions and field works were used to collect plant samples (Cacatian & Tabian 2023) as well as additional data on the identity of the plants. The research team was joined in the field by the key informants who also served as local guides and were asked to mention wild edible plants that came into their minds; information on the wild edible plants and their mode of collection and preparation prior to consumption were recorded. The recorded data included: 1) vernacular names of the plant; 2) habit; 3) edible parts; 4) mode of harvest/preparation/consumption; 5) availability of the plants; 6) conservation status; and 7) additional information about the plants.

Plant Collection and Identification

Approximately 600 g each of the plant samples were collected from the four study sites, i.e., *Barangays* Bagong, Cabintan, Gaas, and Lake Danao. Fresh fruit and leaf samples were carefully placed in plastic resealable bags and temporarily stored in styrofoam boxes with ice to prevent deterioration. Subsequently, the samples were transported to the University of the Philippines Cebu Biology laboratory for analysis. For plant identification purposes, fruit samples were preserved in 500 mL glass jars containing 95% ethanol. Leaves and stem samples were also collected to prepare plant vouchers. Initial plant identification was carried out using Co's Digital Flora of the Philippines (Pelser *et al.* 2011). Digitized voucher specimens were then sent to the University of the Philippines Los Baños for verification.

Sample Preparation

Plant samples were meticulously collected, taking care to minimize external contamination. The collected samples (fruits, leaves, and tubers) were washed thoroughly with distilled water. Subsequently, the fruit samples were carefully sectioned by cutting them open or slicing them into thin, uniform pieces. A subset of the samples, earmarked for moisture content determination, underwent immediate processing (Islary *et al.* 2016).

The bulk of the samples were subjected to a thorough drying process, initially through air-drying for a duration of 24 hours under controlled laboratory conditions then dried in a hot air oven at 50 °C until their weight stabilized, indicating the complete removal of the moisture (Korish 2016; Nielsen 2010). Upon achieving constant weight, all samples were pulverized to a fine, uniform consistency and placed in airtight plastic resealable bags (Islary *et al.* 2016; Korish 2016) to prevent moisture ingress. These bags were properly labelled then stored at room temperature.

Quantitative Proximate Analyses

The determination of the proximate composition of the WEPs was conducted in accordance with established protocols outlined by the Association of Official Analytical Chemists (AOAC 2000). These analyses were done in triplicate to ensure precision and reliability.

Determination of Moisture Content

Three grams of each fresh plant sample were carefully weighed and placed in a crucible that had been preheated to a constant weight in a hot air oven. The plant samples were subjected to controlled heating at a temperature of 105 °C to constant weight, which was confirmed when the difference in sample weights did not exceed 0.0005 g. Moisture content was calculated using Equation (1).

$$Moisture\ (\%) = \frac{Fresh\ weight - Dry\ weight}{Fresh\ weight} \times 100 \qquad (1)$$

Determination of Crude Fiber Content

Two grams per pulverized sample was subjected to boiling in a 0.25 N sulfuric acid (H_2SO_4) solution. Subsequently, the mixture was subjected to filtration using a muslin cloth, and the residue was washed three times with hot distilled water. The residue from the previous step was further processed with 100 mL 0.313 N sodium hydroxide (NaOH). The resultant mixture was again subjected to filtration, followed by washing with hot distilled water, 0.5 N H_2SO_4, and 50% ethanol. The final residue obtained was placed in a crucible and dried at 100 °C to constant weight. The dried sample was allowed to cool in a desiccator for several minutes and was then weighed, establishing the initial weight (C_1). Subsequently, the sample was incinerated in a muffle furnace at a maintained temperature of 550 °C for 5 hours and then cooled in a desiccator. After cooling, the sample was reweighed (final weight, C_2). The percentage of crude fiber was determined using Equation 2.

$$\%\ Crude\ Fiber = \frac{C_1 - C_2}{Fresh\ weight} \times 100 \qquad (2)$$

Determination of Crude Fat Content (Soxhlet-Method)

The quantification of crude fat content was conducted using the Soxhlet method with petroleum ether extraction. The Soxhlet extraction apparatus was prepared by heating the Soxhlet beakers to constant weight. The final weight of these beakers was recorded as a reference. Two grams of each of the pulverized plant samples were securely enclosed within improvised filter paper tea bags specially designed for this purpose; the sample-containing tea bags were then placed inside extraction thimbles which were positioned within the Soxhlet beakers. The apparatus was set up and run in a water bath to facilitate fat extraction. Subsequently, the Soxhlet beakers were subjected to drying to eliminate excess ether solution, with subsequent weighing performed until a constant weight was attained. The determination of crude fat content was computed using Equation (3).

$$Crude\ Fat\ (\%) = \frac{Weight\ of\ fat}{Weight\ of\ the\ sample}\ x\ 100 \qquad (3)$$

Determination of Ash Content

Approximately 2 - 3 g of each of the samples were placed in a crucible preheated to a constant weight. The initial weight was recorded, along with the combined weight of the crucible and the sample. The sample in the crucible was subjected to high-temperature treatment in a muffle furnace at 550 °C for 6 hours. Following the ashing procedure, the crucible and its contents were allowed to cool in a desiccator to prevent moisture absorption. Subsequently, the ash weight was determined. The percentage of ash content was calculated using Equation (4).

$$Ash\ Content\ (\%) = \frac{Ash\ weight}{Weight\ of\ the\ plant\ sample}\ x\ 100 \qquad (4)$$

Determination of Total Solids

Total solids, representing the dry matter in the plant samples, was calculated by subtracting the moisture percentage from 100 (Equation 5).

$$Total\ solids = 100 - Moisture\ content \qquad (5)$$

Determination of Oxalic Acid

Five grams each of the pulverized plant samples were mixed with 3 M sulfuric acid (H2SO4) solution and stirred for 1 hour. The resulting mixture was filtered and then gently heated between 80 °C to 90 °C using a hot water bath. The solution was titrated against 0.05 M potassium permanganate ($KMnO_4$) solution, with the temperature of the mixture consistently maintained at 70 °C. The titration endpoint was identified by the persistence of a light pink color for 15 seconds. The oxalic acid content was determined by calculating the equivalent milligrams of oxalate in 1 mL of 0.05 M $KMnO_4$ solution.

Determination of Alkaloids Percentage

In a 250-mL beaker, 5 g each of the pulverized plant samples was added with 200 mL of 20% acetic acid solution (CH_3COOH). The beaker containing the resulting solution was covered with a watch glass and allowed to stand for 4 hours. The mixture was then filtered and concentrated to 50 mL using a hot water bath; this was then added with concentrated ammonium hydroxide (NH_4OH) until the precipitate was complete. The solution was allowed to settle for 3 hours and decanted. The supernatant was discarded and the resulting precipitate was washed with 20 mL of 0.1 M NH_4OH. The solution was then filtered with a pre-weighed Whatman no. 1 filter paper; the filter paper containing the precipitate was air-dried before weighing. The total alkaloids percentage was determined using Equation (6).

$$Alkaloids\ (\%) = \frac{Weight\ of\ the\ residue}{Weight\ of\ the\ sample}\ x\ 100 \qquad (6)$$

Determination of Vitamin C Content

The vitamin C content in the plant samples was determined following the methodology outlined by Rai and Panda (2014), with some modifications. Prior to the analysis, an extracting solvent was prepared by combining 0.75 g ethylenediaminetetraacetic acid (EDTA), 5.0 g oxalic acid ($C_2H_2O_4$), ammonium molybdate ($(NH_4)_2MoO_4$), orthophosphoric acid (H_3PO_4), 5% sulfuric acid (H_2SO_4), and distilled water. From this solution, 11 mL was taken comprising 4 mL of EDTA, $C_2H_2O_4$, 2 mL $(NH_4)_2MoO_4$, 1 mL 5% H_2SO_4, 1 mL H_3PO_4, and 3 mL distilled water. This solution was added to 2.0 g of finely pulverized plant sample and placed in a 15 mL test tube. The test tube was vigorously shaken and allowed to stand for approximately 15 minutes. Subsequently, the resulting mixture was filtered using Whatman no. 1 filter paper, with the residue being discarded, and the filtrate was measured for its absorbance at 520 nm. For standardization, a standard curve was constructed using various concentrations of vitamin C (100%, 75%, 50%, 25%, 10% and 5%). The same procedure was carried out with the standard solutions. The vitamin C content was calculated using the linear equation derived from the standard curve.

Mineral Analysis

One hundred grams of each of the ground samples were sent to Technolab Analytical Group in Mandaue City, Cebu, Philippines, for the determination of the mineral contents.

Data Analysis

All experiments were carried out in triplicates; for quantitative data, the values were expressed as mean ± standard deviation.

RESULTS AND DISCUSSION

Wild Edible Plants and Their Uses

A total of 15 plant species belonging to 15 genera and 13 families were documented (Table 1) during the Key Informant (KI) interview and during the field excursions, which was participated by 4 individuals recommended by the head of the City Agriculture Office. These individuals included farmers and forest rangers who had extensive knowledge of the local plant diversity. The family that was represented the most was *Arecaceae*, with 3 species, followed by the rest of the families, each having 1 taxon. The plant species mentioned frequently by the key informants was *Rubus fraxinifolius*, locally known as "*binit*" (Table 1). About 47% of the documented plants were trees, 33% were vines, 13% herbs, and 7% shrubs (Table 1). Out of the 15 plants mentioned, only 8 species were collected for nutrient analyses, as these were the only plants available for collection during the March 2019 sampling. *Artocarpus blancoi, Dillenia philippinensis, Diplazium esculentum*, *Melothria pendula*, and *Passiflora edulis* were also included by Cacatian & Tabian (2023) in the list of indigenous wild food resources in northwestern Cagayan, Philippines.

Of the 15 plant species identified, at least 3 species have already been commercialized, i.e., *"kaong"* (*Arenga pinnata*) (used as a food ingredient), "rattan" (*Calamus* sp.), and *"mirinda"* (Passion Fruit) (*Passiflora edulis*). Most of the mentioned plants, primarily fruits, can be consumed raw, but a few wild fruits can also be used as food additives or seasoning (*katmon*) (*Dillenia philippinensis*) and can be processed into wine (*binit*) (*Rubus fraxinifolius*). A number of edible plants serve other purposes, due to the medicinal value that they may possess (Ramnath & Razal 2019). The fruits of *"pipinong gubat"* and *"apitngaw"* have been mentioned to have medicinal properties. *"Pipinong gubat"* (*Melothria pendula*) can be brewed into herbal tea, and *"apitngaw"* (*Melastoma malabathricum*) is believed to relieve toothache.

One notable wild edible plant in the study is the wild yam, locally known as *"kut"* (*Dioscorea hispida*). It is a thorny creeping plant that grows near rock boulders and alongside river streams. The plant contains *dioscorine*, a toxic compound characteristic of the family *Dioscoreaceae*. Due to this, the tuber must be thoroughly processed to remove the toxins before consumption. According to the KI, this process takes days or even weeks. *"Kut"* is a traditional food in *Barangay* Bagong and is usually harvested and consumed during the Catholic Holy Week celebration, where locals would make *kakanin* (local rice or root crop delicacies). The collection and consumption of this wild yam happens in adverse situations as the effort to include them more frequently in diets requires much processing (Ramnath & Razal 2019).

Aside from wild edible fruits, some WEPs are cooked as vegetable dishes, such as "*pugahan*" (*Caryota mitis*) and *"pako"* (*Diplazium esculentum*) salad. The edible part of *"pugahan"*, aside from its fruits, is the *'ubod'* or the heart of the palm. Locals cut open the base stem of the plant to reveal the *'ubod'* which, according to the KI, tastes like carabao meat when cooked. On the other hand, *"pako"* is an edible fern that can be consumed in salads or stir-fried with oyster meat or any other preferred ingredient. The plant can be harvested abundantly along the side of Lake Danao.

Table 1 List of wild edible plant species documented in the ethnobotanical survey conducted in three selected *barangays* in Ormoc, Leyte, Philippines

Family	Scientific name	Common name	Local name	Habit	Edible parts	Method of preparation, consumption	Food category	Conservation status and availability
Annonaceae	*Annona montana* (Macfad)	Mountain soursop	Wild guyabano	Tree	Fruit	Consumed raw	Fruit	Not Threatened/ Available
Arecaceae	*Arenga pinnata* (Wurmb) Merr.	Sugar palm	Native kaong	Tree	Fruit	Processed	Fruit, Food Ingredient	Not Threatened/ Available
Arecaceae	*Calamus* sp.	Rattan Palm	Rattan	Vine	*Ubod* (heart of palm)	Cooked	Vegetable	Not Threatened/ Available
Arecaceae	*Caryota mitis* Lour.	Clustered Fishtail Palm	Pugahan	Tree	*Ubod*, Fruit	Cooked	Fruit, Vegetable	Not Threatened/ Available
Athyriaceae	*Diplazium esculentum* (Retz.) Sw.	Fiddlehead fern	Paku	Herb	Fronds (young shoots)	Cooked, salad	Vegetable	Not Threatened/ Available
Cucurbitaceae	*Melothria pendula* L.	Creeping cucumber	Pipinong gubat	Vine	Fruit	Consumed raw	Fruit, beverage	Not Threatened/ Available
Dilleniaceae	*Dillenia philippinensis* Rolfe	Philippines Simpoh	Katmon	Tree	Fruit	Cooked	Seasoning, Food Ingredient	Not Threatened/ Available
Dioscoreaceae	*Dioscorea hispida* Dennst.	Intoxicating yam	Kut, wild yam	Vine	Root, Tuber	Cooked	Staple	Not Threatened/ Available
Flacourtiaceae	*Flacourtia jangomas* (Lour.) Raeusch.	Indian Plum, Indian Cherry	Seriales	Tree	Fruit	Consumed raw	Fruit	Not Threatened/ Available
Melastomaceae	*Melastoma malabathricum* L.	Malabar gooseberry; Indian Rhododendron	Apitngaw	Shrub	Fruit, seeds	Consumed raw	Fruit	Not Threatened/ Available
Moraceae	*Artocarpus blancoi* (Elmer) Merr.	Antipolo (Tagalog)	Antipo	Tree	Fruit, seeds	Cooked, roasted seeds	Fruit, snack	Not Threatened/ Available
Myrtaceae	*Decaspermum parviflorum* (Lam.) A.J. Scott	Silky myrtle	Beri	Tree	Fruit	Consumed raw	Fruit	Not Threatened/ Available
Pasifloraceae	*Passiflora edulis* Sims	Passion fruit	Mirinda	Vine	Fruit	Consumed raw	Fruit	Not Threatened/ Available
Rosaceae	*Rubus fraxinifolius* (Poir)	Mountain raspberry	Binit	Vine	Fruit	Consumed raw, processed	Fruit	Not Threatened/ Available
Zingiberaceae	*Alpinia elegans* (C. Presl) K.Schum.	Tagbak (Tagalog)	Panaon	Herb	Fruit, Rhizome	Consumed raw	Fruit	Not Threatened/ Available

Proximate Composition

The 8 species available for collection and analysis included *Annona montana*, *Decaspermum parviflorum*, *Diplazium esculentum*, *Dillenia philippinensis*, *Dioscorea hispida*, *Flacourtia jangomas*, *Melastoma malabathricum*, and *Rubus fraxinifolius*. The nutrient composition of these plants is summarized in Table 2. The parameters analyzed were moisture content, dry matter or total solids, ash content, crude fat, and crude fiber.

Moisture and Dry Matter

Measuring the amount of moisture in a plant is the first step in assessing the overall nutritional value of plants. A relatively high moisture content would reveal that the plant is more liable to microbial degradation (Datta *et al.* 2019). Low moisture content in plants indicates the presence of insoluble materials and entails longer shelf life with reduced susceptibility to microbial infection; this is determined by the amount of total solids in plants (the composition of plants excluding the water content).

As shown in Table 2 the wild edible fruits *D. philippinensis* (91.17 ± 0.40 g/100 g), *M. malabathricum* (78.10 ± 1.00 g/100 g), *A. montana* (78.51 ± 12.43 g/100 g), *R. fraxinifolius* (77.94 ± 1.20 g/100 g), and *Decaspermum parviflorum* (66.76 ± 0.64 g/100 g) had relatively higher moisture content. The edible fern, *D. esculentum* (89.21 ± 1.37 g/100 g) that grows in damp areas, and wild yam, *D. hispida* (63.46 ± 2.53 g/100 g), also exhibited high moisture content. The unripe fruits of *Flacourtia jangomas* had relatively low moisture content (27.90 ± 2.34 g/100g), which is typical of young, developing seed fruits.

Ash

Ash content, which represents the inorganic residue remaining after the complete oxidation of organic matter in food samples, indicates the availability of inorganic minerals in plants (Datta *et al.* 2019; Mundaragi *et al.* 2017; Talang *et al.* 2023; Yiblet & Adamu 2023). As observed in Table 2, most of the wild plants collected had relatively high ash content exceeding up to 20% with *D. parviflorum* having the highest among the plants analyzed, followed by *F. jangomas.* The high ash content in these fruits, such as *D. parviflorum* and *F. jangomas* can be attributed to their unripe state and their large, multiple seeds. The relatively high ash content in other wild plants in the study indicated that these plants contained high amounts of minerals.

Table 2 Proximate composition of wild edible plant species found in three *barangays* of Ormoc City

Plant species	Plant part analyzed	Moisture (g/100 g)	Dry matter (g/100 g)	Ash (g/100 g)	Crude fat (g/100 g)	Crude fiber (g/100 g)
Annona montana	Fruit (ripe)	78.51 ± 12.43	21.49 ± 12.43	13.96 ± 1.06	-	-
Decaspermum parviflorum	Fruit (unripe)	66.76 ± 0.64	33.24 ± 0.53	20.80 ± 2.45	0.84 ± 0.58	5.72 ± 0.11
Diplazium esculentum	Leaves	89.21 ± 1.37	10.79 ± 1.37	9.74 ± 0.38	1.35 ± 0.81	13.52 ± 1.85
Dillenia philippinensis	Fruit (ripe)	91.17 ± 0.40	8.83 ± 0.40	7.00 ± 1.06	1.37 ± 0.06	7.15 ± 0.002
Dioscorea hispida	Tuber	63.46 ± 2.53	36.54 ± 2.53	9.96 ± 1.57	0.66 ± 0.499	3.88 ± 0.19
Flacourtia jangomas	Fruit (unripe)	27.90 ± 2.34	72.90 ± 2.34	12.42 ± 2.42	0.91 ± 1.10	14.63 ± 0.47
Melastoma malabathricum	Fruit (ripe)	78.10 ± 1.00	21.90 ± 1.00	6.72 ± 0.36	-	-
Rubus fraxinifolius	Fruit (ripe)	77.94 ± 1.20	22.06 ± 1.20	15.57 ± 0.08	6.97 ± 1.96	26.59 ± 1.17

Notes: - = parameters not performed due to inadequate amount of samples for analysis.

Crude Fat and Crude Fiber

Crude fat, a term used to describe the amount of fats in feedstuffs, food, and plants, represents the combination of free lipids and other fat-soluble materials present in a sample that can be dissolved in the solvent being used for extraction (AAFCO Lab Methods and Services Committee 2014). The crude fat content among the analyzed plants ranged from 0.66 g/100 g to 6.97 g/100 g (Table 2), with *R. fraxinifolius* having the highest fat content and wild yam having the lowest among the samples.

Crude fiber is the most common measurement of fiber in plants. In this study, *R. fraxinifolius* had the highest crude fiber content at 26.59 g/100 g, followed by *F. jangomas* at 14.63 g/100 g and *D. esculentum* at 13.52 g/100 g. The rest have fairly moderate amounts of fiber content. The crude fiber contents of the fruits of *R. fraxinifolius, F. jangomas* and the leaves of *D. esculentum* are higher than the dietary fiber content of commonly consumed fruits and vegetables like apple, banana, asparagus, carrot, or broccoli (Vicente *et al.* 2014). Although crude fiber does not represent the total dietary fiber and may underestimate the total amount of dietary fiber present in plants, the results may imply that these plants can be good alternative sources of fiber.

Mineral Content

Minerals are inorganic substances that comprise one of the four major classes of micronutrients, which are essential nutrients needed in small amounts in the body. Minerals can be classified into two classes: macroelements and microelements (trace elements) (Siddiqui *et al.* 2014). These minerals are found in plants, and the composition and quantity of these elements vary depending on factors such as the type of cultivar, growth conditions, type of substrate, fertilizers used, nutrients requirement of the plant, and growth stages of the plant at the time of harvest (Jākobsone *et al.* 2015).

The mineral composition of the wild edible plants in the study is presented in Table 3. The parameters analyzed include sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu), zinc (Zn), and manganese (Mn).

M. malabathricum had the highest sodium (74.9 mg/kg) and calcium (5,017 mg/kg) contents among all the plant samples, followed by *R. fraxinifolius* at 74.8 mg/kg for Na, and 1,476 mg/kg for Ca. The Na content of *D. parviflorum* was 67.2 mg/kg, while the Ca content of *F. jangomas* and *A. montana* was 1,675 mg/kg and 721 mg/kg, respectively. *D. hispida* had the least amount of calcium among the samples collected in Ormoc City. The calcium content of the plants tested was higher than in some cultivated vegetables like lettuce, cabbage, and spinach (Datta *et al.* 2019).

Results showed that the WEPs in this study are not good sources of potassium since the potassium levels in the samples were below the detection limit (< 0.01 mg/kg). The wild edible fruits from Ormoc City contained high amounts of magnesium ranging from 1,650 mg/kg to 20,802 mg/kg. *M. malabathricum* had the highest magnesium content (20,802 mg/kg) among all the plants analyzed, followed by *R. fraxinifolius* (19,116 mg/kg). Magnesium aids in preventing muscle degeneration, growth retardation, cardiomyopathy, immunologic dysfunction, and bleeding disorders, among others (Datta *et al.* 2019).

Among the plants analyzed, *D. esculentum* had the highest iron content (31.5 mg/kg), followed by *D. philippinensis* (30.6 mg/kg) and *M. malabathricum* (23.5 mg/kg). The remaining samples had iron levels below the detection limit. For copper, *D. esculentum* leaves had the highest copper content (38.5 mg/kg) among all the plants. Zinc concentration was high in *D. esculentum* (44.4 mg/kg), *F. jangomas* (34.1 mg/kg), and *M. malabathricum*, (28.9 mg/kg), while it was low in *A. montana* (0.39 mg/kg). Lastly, for manganese, *M. malabathricum* had the highest manganese content (298 mg/kg), while *D. parviflorum* had the lowest manganese concentration (3.2 mg/kg). Iron, zinc, copper, sulfur, manganese, and iodine, are consumed in smaller amounts (< 100 mg/dL) (Linkon *et al.* 2015). Although these microelements play essential roles in various metabolic processes in the body, they are needed only in small amounts, and their intake should be regulated.

The recommended dietary allowance (RDA) for calcium (1,000 mg/day), magnesium (400 mg/day), and iron (8 mg/day) (Datta *et al.* 2019) suggests that the plants can supplement the daily mineral requirement.

Table 3 Mineral composition of wild edible plants found in three *barangays* in Ormoc City, Leyte

Plant species	Plant part analyzed	Fe (mg/kg)	Cu (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Na (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)
Annona montana	Fruit (ripe)	6.34	9.91	0.39	7.12	15.3	< 0.01*	721	11,984
Decaspermum parviflorum	Fruit (unripe)	6.34	11.4	< 0.01*	3.2	67.2	< 0.01*	276	1,650
Diplazium esculentum	Leaves	31.3	38.5	44.4	19.4	51.9	<0.01*	355	13,294
Dillenia philippinensis	Fruit (ripe)	30.6	8.35	< 0.01*	13.9	69	< 0.01*	427	13,780
Dioscorea hispida	Tuber	7.01	11.7	< 0.01*	5.0	8.94	< 0.01*	7.31	2,744
Flacourtia jangomas	Fruit (unripe)	< 0.01*	13.2	34.1	82.5	< 0.01*	< 0.01*	1,675	4,129
Melastoma malabathricum	Flower	23.5	11.7	28.9	298	74.9	< 0.01*	5,017	20,802
Rubus fraxinifolius	Fruit (ripe)	12.4	10.1	15.1	31.5	74.8	< 0.01*	1,476	19,116

Note: * = method detection limit.

Table 4 Vitamin C, alkaloids, and oxalate content of wild edible plant species in three selected *barangays* in Ormoc City, Leyte

Plant species	Plant part analyzed	Vitamin C content (g/100 g)	Alkaloids content (g/100 g)	Oxalate content (g/100 g)
Annona montana	Fruit (ripe)	72.47 ± 2.21	-	0.95 ± 0.01
Decaspermum parviflorum	Fruit (unripe)	16.15 ± 4.51	0.56 ± 0.001	0.0057 ± 0.002
Diplazium esculentum	Leaves	21.94 ± 6.55	0.68 ± 0.14	0.2 ± 0.02
Dillenia philippinensis	Fruit (ripe)	18.17 ± 3.90	0.72 ± 0.013	0.45 ± 0.01
Dioscorea hispida	Tuber	25.90 ± 2.93	0.50 ± 0.05	0.29 ± 0.01
Flacourtia jangomas	Fruit (unripe)	36.61 ± 2.90	0.98 ± 0.03	0.074 ± 0.007
Melastoma malabathricum	Fruit (ripe)	82.58 ± 14.27	-	0.30 ± 0.05
Rubus fraxinifolius	Fruit (ripe)	40.28 ± 8.03	1.36 ± 0.11	0.52 ± 0.03

Note: - = parameters not performed due to inadequate amount of samples for analysis.

Vitamin C

Vitamin C, chemically known as ascorbic acid, is an important factor in assessing the quality of fruits (Khilari & Sharma 2016). In addition to the polyphenols present in plants, vitamin C also contributes to the antioxidative properties of plants. L-ascorbic acid cannot be synthesized in humans and must be, therefore, consumed from food sources. It is well known that plant-based foods, especially fruits, are generally high in vitamin C, making them good sources of ascorbic acid (Lykkesfeldt *et al.* 2014). Vitamin C plays a crucial role in various metabolic processes, such as the formation of bile salts, serotonin production, the reduction of allergic activity, and the scavenging of free radicals (Chambial *et al.* 2013).

As shown in Table 4, low vitamin C content was observed in *D. philippinensis* (*katmon*) fruits and unripe fruits of *D. parviflorum* and *F. jangomas.* Relatively high vitamin C content was found in *M. malabathricum* (82.58 ± 14.27 g/100 g), followed by *A. montana* (72.47±2.21 g/100 g), and *R. fraxinifolius* (40.28± 8.03 g/100 g). The edible fern *D. esculentum* (21.94 ± 6.55 g/100 g) and *D. hispida* (25.90 ± 2.93 g/100 g) had lower vitamin C content. Some of the fruits in this study could help supplement the recommended daily allowance of ascorbic acid for different life stages and groups aged 1- 70 years which is 15 to 120 mg per day (Ojelel *et al.* 2020).

Antinutrients (Alkaloids and Oxalate)

Compounds that have specific functions for plant growth or defense mechanism (Fekadu Gemede 2014) but can be toxic and/or anti-nutritive in humans, are labeled as antinutrients; they result in health hazard affecting digestion and the absorption of essential nutrients (Lo *et al.* 2018; Popova & Mihaylova 2019). They bind to minerals and other nutrients and reduce their bioavailability and digestibility, excess consumption of these substances may have adverse effects and may lead to toxicity (Nath *et al.* 2022; Lo *et al.* 2018; Aina *et al.* 2012; Fekadu Gemede 2014). Alkaloids are a group of naturally occurring nitrogen-containing compounds produced from secondary metabolic pathways in plants to protect plants from herbivory and pathogenic attacks (Alves de Almeida *et al.* 2017).

The quantification of alkaloid and oxalate contents is summarized in Table 4. In this study, the amounts of alkaloids present in the WEPs ranged from 1.36 g/100 g to 0.56 g/100 g, with *R. fraxinifolius* exhibiting the highest and *D. hispida* the lowest. These values are higher than the lethal dose for alkaloids which is only 20 mg/100 g (Ifemeje *et al.* 2014). This can mean that these plants may not be safe for consumption. However, the toxic effects of alkaloids depend on the type of alkaloids present in the plant. Therefore, characterization of this class of compounds is recommended.

The amounts of oxalate in the plants analyzed ranged from 0.95 g/100 g to 0.0057 g/100 g, with the highest observed in *A. montana* fruits and the lowest in *D. parviflorum*. Oxalates are substances that can bind with other minerals (e.g., calcium) and form insoluble salts (Petroski & Minich 2020).

Summary of the Proximate Composition, Mineral Composition, Alkaloids and Oxalates

A total of 15 edible plant species, representing 13 families, were identified in the study. *D. philippinensis* had the highest moisture content, followed by *M. malabathricum*, *A. montana,* and *R. fraxinifolius*. Most of the wild plants collected had relatively high ash content exceeding up to 20% with *D. parviflorum* having the highest among the plants analyzed, followed by *F. jangomas,* indicating a rich mineral content. *R. fraxinifolius* had the highest crude fiber content, followed by *F. jangomas* and *D. parviflorum*. The rest had moderate amounts of fiber content.

The fruits of *M. malabathricum* exhibited the highest Ca, Na, Mg, and Mn content, as well as the highest vitamin C content. *R. fraxinifolius* had the second highest Na content, and *F. jangomas* had the second highest Ca content. *D. esculentum* leaves had the highest iron, copper and zinc content, and a relatively high magnesium content. *D. philippinensis* and *M. malabathricum* also had relatively high iron content. The remaining samples had iron levels below the detection limit.

The fruits of *A. montana*, *R. fraxinifolius,* and *M. malabathricum* showed a relatively high vitamin C content. *R. fraxinifolius* exhibited the highest alkaloids content and *D. hispida* the lowest, while oxalate content was highest in *A. montana* fruits and the lowest in *D. parviflorum* fruits.

WEPS Identified but not Collected and Analyzed

Although 7 out of the 15 plant species identified as edible were not collected and analyzed, studies indicate that they are also considered edible in other countries and regions.

The sap of *Arenga pinnata* may be converted to palm sugar, which has a low glycemic index, making it a healthier alternative to refined sugar, particularly for diabetics (Haagen & Lantican 2014). In Bhutan, certain villages believe that soup made from the young shoot of *Calamus* sp., helps alleviate nausea (Matsushima *et al.* 2006). Similarly, local communities in Central Kalimantan in Indonesia consider *Calamus* sp. a food source (Fambayun & Kalima 2022). A study on consumption practices in Assam, India, revealed that *Calamus* sp. shoots are eaten in various forms, i.e., raw, boiled, fried, roasted, and often cooked with other ingredients, such as fish, meat, black gram pulses, etc. (Thakur & Sheth 2015). Another study found that *D. angustifolia*, and *D. fissa* are the preferable rattan used for food by the community near peatland areas in Central Kalimantan, both for daily sustenance and cultural activities. (Fambayun & Kalima 2022).

Although *Caryota mitis* and *Alpinia elegans* were identified by key informants in this study as edible, they are primarily valued for their medicinal properties (Dalisay *et al.* 2018; Naïve *et al.* 2019; Shahriar *et al.* 2017). In Bangladesh the roots and fruits of *Caryota mitis* have been reported to be traditionally used by folk medicinal practioners of a number of villages for treatment of constipation and hemorrhoids (Shahriar *et al.* 2017). *Alpinia elegans,* an endemic Philippine medicinal plant, is known for treating musculoskeletal diseases, hemoptysis, headache, migraine, stomachache, and as an anti-relapse for women. (Naïve *et al.* 2019; Dalisay *et al.* 2018).

Melothria pendula L., now naturalized in Peninsular Malaysia, mainland Sumatra, Borneo (Sabah), the Philippines, and Sulawesi, thrives in urban areas and grows spontaneously along roadsides, in gardens, open spaces, and ditches, burial grounds and abandoned land (Husaini *et al.* 2024). In parts of Mexico, it is used as food and in beverages (Guerrero-Torres *et al.* 2023), while in the Philippines, it is recognized as a common medicinal plant (Raju *et al.* 2021).

The fruit of *Passiflora edulis* is considered a rich source of vitamin A, thiamine, riboflavin, niacin, calcium, phosphorus, and vitamin C. In Colombia, its pulp is used to prepare juices and soft drinks (Jimenez *et al.* 2011). Among Brazilian passion fruit species, *Passiflora edulis* Sims is the most cultivated and valued for its flavor and aroma (Barbosa Santos *et al.* 2021).

CONCLUSION

The plants analyzed in this study were rich in essential nutrients, including mineral (Ca, Na, Mg, Mn, Fe, Cu and Zn), crude fiber and vitamin C. The different plants excelled in different nutritional aspects, suggesting a diverse dietary potential. These plants play a crucial role in the local community, providing not only sustenance but also medicinal applications. Further research and conservation efforts should be encouraged to harness the nutritional and economic potential of these plants while ensuring their sustainable utilization and preservation. Additionally, incorporating information about WEPs into disaster preparedness and food security policies could help safeguard vulnerable communities in disaster-prone regions, like the Philippines.

REFERENCES

[AAFCO] Association of American Feed Control Officials. [Internet]. 2014. Available from: https://www.aafco.org/Portals/0/SiteContent/Laboratory/Fat_Best_Practices_Working_Group/Crude_Fat_Methods_Considerations.pdf

Aina VO, Sambo B, Zakari A, Haruna MSH, Umar H, Akinboboye RM, Mohammed A. 2012. Determination of nutritional and anti-nutrient content of *Vitis vinifera* (Grapes) grown in Bomo (Area C) Zaria, Nigeria. Adv J Food Sci Tech 4:445-48.

Alves de Almeida AC, de-Faria FM, Dunder RJ, Manzo LPB, Souza-Brito ARM, Luiz-Ferreira A. 2017. Recent trends in pharmacological activity of alkaloids in animal colitis: Potential use for inflammatory bowel disease. Evidence-Based Complementary and Alternative Medicine:1-24. DOI: 10.1155/2017/8528210

Anbessa B, Lulekal E, Getachew P, Hymete A., 2024. Ethnobotanical study of wild edible plants in Dibatie District, Metekel zone, Benishangul Gumuz Regional State, Western Ethiopia. J Ethnobiol Ethnomed 20(1):27.

[AOAC] Association of Official Analytical Chemists. 2000. Official Methods of Analysis. 17th Edition. Arlington (US): Association of Official Analytical Chemists.

Asio JM. 2020. Disaster knowledge and household preparations of selected communities in Central Luzon, Philippines: Basis for enhanced community disaster education program. IJ-HuMaSS) 3(2):44-51.

Barbosa Santos T, de Araujo FP, Figueiredo Neto A, de Freitas ST, de Souza Araújo J, de Oliveira Vilar SB, Brito Araújo AJ, Lima MS. 2021. Phytochemical compounds and antioxidant activity of the pulp of two Brazilian passion fruit species: *Passiflora cincinnata* Mast. and *Passiflora edulis* Sims. Int J Fruit Sci 21(1):255-69.

BP Integrated Technologies, Inc. 2019. Ormoc weather monitoring system display. [Internet]. Available from: http://ormocweb.bpit-inc.com/. Accessed on 4 March 2019.

Buenavista DP, Mollee EM, McDonald M. 2022. Any alternatives to rice? Ethnobotanical insights into the dietary use of edible plants by the Higaonon tribe in Bukidnon Province, the Philippines. Regional Sustainability 3(2):95-109.

Cacatian SB, Tabian JLT. 2023. Floristic composition and diversity of indigenous wild food resources in northwestern Cagayan, Philippines. Biodiversitas 24(4):2324-33. DOI: 10.13057/biodiv/d240446

Chambial S, Dwivedi S, Shukla KK, John PJ, Sharma P. 2013. Vitamin C in disease prevention and cure: An overview. Indian J Clin Biochem 28:314-28. DOI: 10.1007/s12291-013-0375-3

Dalisay JAGP, Bangcaya PS, Naive MAK. 2018. Taxonomic studies and ethnomedicinal uses of Zingiberaceae in the mountain ranges of northern Antique, Philippines. BFIJ (Biological Forum–An International Journal) 10(2):68-73.

Datta S, Sinha BK, Bhattacharjee S, Seal T. 2019. Nutritional composition, mineral content, antioxidant activity and quantitative estimation of water soluble vitamins and phenolics by RP-HPLC in some lesser used wild edible plants. Heliyon 5(3):e01431. DOI: 10.1016/j.heliyon.2019.e01431

Demir E, Turfan N, Özer H, Üstün NS, Pekşen A. 2020. Nutrient and bioactive substance contents of edible plants grown naturally in Salıpazarı (Samsun). Acta Sci Pol-Hortoru 19(1):151-60.

Duguma HT. 2020. Wild edible plant nutritional contribution and consumer perception in Ethiopia. Int J Food Sci 2020(1):2958623.

Dumalan R. 2023. State of the mangrove in Ormoc City. Conference Paper presented at the State of the Mangrove Summit: Central and Eastern Visayas Proceeding. p.34-44.

Fambayun RA, Kalima T. 2022. Rattan: Its role for food-alternative of the community near the peatland areas in Central Kalimantan. In IOP Conf Ser Earth Environ Sci 959(1):012062.

Fekadu Gemede H. 2014. Antinutritional factors in plant foods: potential health benefits and adverse effects. Int J Food Sci Nutr 3(4):284-89.

Guerrero-Torres P, Hernández-Sandoval L, Casas A. 2023. *Melothria pendula* L., *Melothria pringlei* (S. Watson) Mart. Crov., *Melothria trilobata* Cogn. Cucurbitaceae. In: Casas A, Vazquez JJB (Editors). Ethnobotany of the Mountain Regions of Mexico. Cham (CH): Springer International Publishing. p.1335-47.

Guzo S, Lulekal E, Nemomissa S. 2023. Ethnobotanical study of underutilized wild edible plants and threats to their long-term existence in Midakegn District, West Shewa Zone, Central Ethiopia. J Ethnobiol Ethnomed 19(1):30.