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Indigenous Knowledge is Critical to Food Security: An Ethnobotanical Study of Food Plants Utilized by the Matigsalug-Manobo Tribe of Bukidnon, Philippines

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ABSTRACT

Indigenous peoples and their knowledge systems are now viewed as a vital component of global targets reflected in the UN Sustainable Development Goals (SDGs). Within the context of achieving SDG 2 (Zero Hunger), ethnobotanical surveys and semi-structured interviews were carried out in collaboration with the Federation of Matigsalug-Manobo Tribal Councils, Inc. (FEMMATRICS), to document the diversity, utilization, and biocultural refugia of agrobiodiversity and wild edible plants of the Matigsalug Manobo Tribe in Sinuda, Bukidnon, Philippines. Results of the quantitative ethnobotanical analysis showed that the Matigsalug-Manobo food system is composed of 62 species of edible plants belonging to 50 genera and 33 botanical families. A total of 804 use-reports were accounted in all 9 FAO use-categories: 4 species (6.45%) were consumed as cereals, 6 species (9.67%) were white roots, tubers, and plantains, 2 species (3.22%) were Vitamin A-rich vegetables and tubers, 18 species (29.03%) were eaten as green leafy vegetables, 15 species (24.19%) were categorized as other vegetables, 3 species (4.83%) were Vitamin A-rich fruits, 28 species (45.16%) were considered as other fruits, 11 species (17.74%) were classified as legumes, nuts, and seeds, and 15 species (24.19%) were used as spices, condiments, and beverages. Unlike the rice-centred diet of the majority of Filipinos, the Matigsalug-Manobo food system relies on diverse staples like cassava, plantain, taro, and other cultivated and wild edible plants. The various collection sites of the Matigsalug-Manobo tribe may be considered as a food biocultural refugia in view of its socio-ecological function in food security, biodiversity conservation, and preservation of indigenous knowledge.

Keywords: ethnobotany, food security, indigenous food system, indigenous peoples, Mindanao, sustainable development goals.

Introduction

Hunger is a global problem affecting almost all countries worldwide. As such, achieving food security is one of the global targets indicated in the UN Sustainable Development Goals (SDGs) (United Nations, 2015). The UN SDG 2 specifically aims to end hunger, achieve food security, improve nutrition and promote sustainable agriculture; SDG Target 2.1 states: "By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round" (United Nations, 2015).

In Asia, widespread hunger, malnutrition, and enormous agricultural loss were already experienced in the 1972-1973 and the 2007-2008 food crises due to the global rice shortage (Dawe, 2010). Historically, this problem was alleviated by importing more rice – the main staple of millions of Filipinos making the Philippines the largest rice importer worldwide (Dawe, 2010; Dawe et al., 2008). The Philippines still held this record in 2019 with a total rice import of 2.9 million tonnes (Reuters, 2020). However, the COVID-19 pandemic has disrupted the food supply chains and the global economy, particularly in agricultural products (Lin and Zhang, 2020). About 15 million Filipino families consume rice at approximately 463 kg per family per year or 8.9 kg a week (Philippine Statistics Authority, 2010).

Arguably, the food shortage may be unnecessary considering the plethora of food plants that have been used in humanity's past, in particular, those by ethnic groups or indigenous peoples. Many indigenous and local communities are holders of extensive knowledge of edible plants, many of which are neglected and underutilized by the majority of the populations (Del-Castillo et al., 2019; Hunter et al., 2019; Kuhnlein et al., 2009; Padulosi et al., 2013; Ulian et al., 2020). Indeed, exploring alternative food sources is not the sole global issue as the Food and Agriculture Organization (FAO) changed the language of food security to "food and nutrition security," indicating the pressing concern on micronutrient deficiencies (Blesh et al., 2019). According to FAO, food and nutrition security means that all people at all times have physical, social, and economic access to food of sufficient quantity and quality in terms of variety, diversity, nutrient content, and safety to meet their dietary needs and food preferences (FAO et al., 2020). Indigenous peoples also maintain their traditional food system to be food secure and resilient independent from the market system (Budowle et al., 2019; Cuevas et al., 2015; Gayao et al., 2018; Meldrum et al., 2020). Indigenous food systems may be described as those foods that indigenous peoples have local access to, without having to purchase them, and within traditional knowledge and the natural environment from farming or wild harvesting (Kuhnlein et al., 2009). This is in contrast to "market foods" or those foods that must be purchased by the community (i.e., packed instant noodles, cooking oil, canned goods, powdered milk, etc.), except for the traditional foods that are locally purchased from other community members such as meat and vegetables.

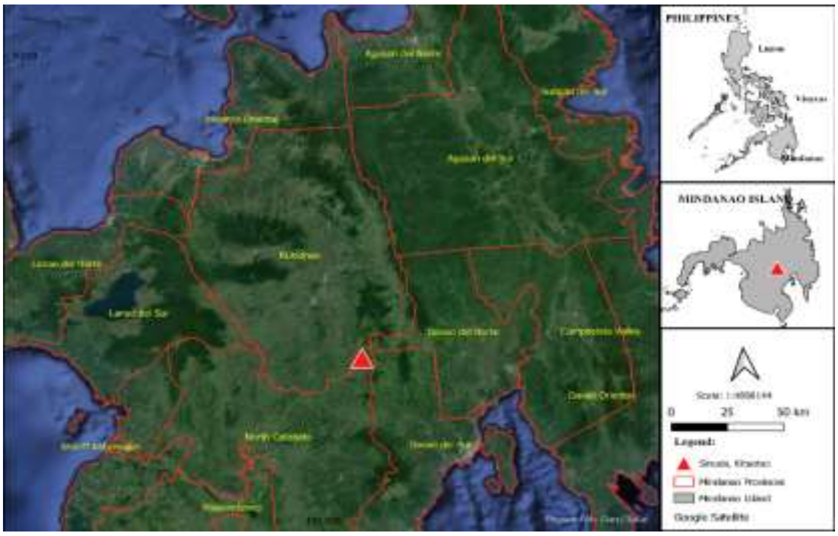
The wealth of indigenous knowledge on agrobiodiversity offers an untapped resource to address malnutrition and food insecurity - the key goals of SDG 2 (Buenavista, 2021; Buenavista et al., 2022). This strategy is particularly promising in a biodiverse yet food-insecure country like the Philippines. With over 10, 000 species of plants (Pelser et al., 2011) and 110 groups of indigenous peoples (Buenavista et al., 2018), the Philippines may be considered one of the most important sites for ethnobotanical research in the Asian region. Moreover, some edible plant species remain unappreciated and undervalued yet, they significantly contribute to the resilience of indigenous communities (Buenavista et al., 2021).

Unfortunately, the encroachment and expansion of agricultural plantations continue to threaten the biocultural landscape owned and/or managed by indigenous peoples, particularly in Mindanao (Huesca, 2016). This rapidly disappearing biocultural landscape harbor a rich biodiversity of cultural and spiritual significance. Yet, the indigenous knowledge system and food ethnobotany of many indigenous peoples are still undocumented despite the pressing concern on food security and the imminent threat of loss of biocultural heritage. One of the understudied and poorly known ethnic groups in the Philippines is the Matigsalug-Manobo tribe of Bukidnon province. The "Matigsalug" which means "resident from the Salug River" (now known as Davao River), is a distinct subgroup of the Manobo ethnolinguistic group living in Mindanao, Philippines (Tawas et al., 1979). Given the biocultural significance of the ancestral land of the Matigsalug-Manobo, this research was carried out to explore the food biocultural refugia and associated food plants utilized by the Matigsalug-Manobo tribe; specifically, this research aims to answer the following questions: 1. Which edible plant species comprise the Matigsalug-Manobo tribe's food system? 2. How are these food plants are utilized based on FAO food-use categories? and 3. In terms of the ethnobotanical index value, which food plant species are most important for the Matigsalug-Manobo tribe?

Method

This research was conducted in Barangay Sinuda, Municipality of Kitaotao, Province of Bukidnon (Figure 1). The Federation of Matigsalug-Manobo Tribal Councils Inc. (Femmatrics) holds a certificate of the ancestral domain over 102,324.8186 hectares within the boundaries of Bukidnon Province, North Cotabato, and the portion of Davao City with a Certificate of Ancestral Domain Title (CADT) No. R10-KIT-0703-0011 issued by the National Commission on Indigenous Peoples (NCIP) last July 25, 2003.

Figure 1.
Location map of Barangay Sinuda in Mindanao Island, Philippines



Before the implementation of the research project, a Matigsalug-Manobo ritual or "panubad" was performed last October 10, 2022. This was followed by conducting several meetings and signing of the Memorandum of Agreement or "Dumduman sa Kasabutan" between the Federation of Matigsalug-Manobo Tribal Councils Inc. (Femmatrics) and Central Mindanao University (Figure 2).

Figure 2.
Matigsalug-Manobo ritual and meeting with tribal chieftains or "Datu"

Ethnobotanical Data Collection

A total of 31 key informants participated in the study. All the key informants were the adults responsible for food collection and/or preparation in the household, either the father, mother, or grandparent, permanent village residents, and of Matigsalug-Manobo tribe descent. After the prior informed consent was obtained, the structured interview was initiated by getting the personal and socio-economic profiles of the key informants. The interview was conducted flexibly following the social norms of the Matigsalug-Manobo tribe.

Some interviews were conducted outside the household, for example, walking interviews whilst within the community, homegarden, or nearby farm (Figure 3). All information was recorded in the datasheet. The interview concluded by reading the respondents' answers for completeness and confirmation. If the plant mentioned during the interview was unknown to the researcher, a guided survey was requested for the respondent to locate the plant for documentation and taxonomic verification.

Figure 3.
Field interviews with the Matigsalug-Manobo key informants

The study considered both wild and cultivated food plants found within the ancestral lands of the Matigsalug-Manobo tribe. The "wild" species referred to the plants that grow simultaneously in self-maintaining populations in a natural or semi-natural habitat without direct human intervention (Heywood, 1999). The term was contrasted with "cultivated" or "domesticated" plant species that have arisen through human action, such as selection or breeding, and that depend on management for their continued existence (Heywood, 1999). This may include all the plants that were gathered (not cultivated), even those growing on cultivated lands instead of forested areas (Termote et al., 2011). All specimens were identified by the author and other taxonomists in the University Herbarium of Central Mindanao University, Bukidnon, Philippines. The botanical nomenclature and taxonomic treatment used in this study were referred from Kew's Plants of the World online database (http://www.plantsoftheworldonline.org/) and Co's Digital Flora of the Philippines (https://www.philippineplants.org/).

Data Analysis

The data collected during fieldwork was organized in a Microsoft Excel spreadsheet for analysis. Using the checklist of all the reported food plants, descriptive statistics on the number and percentage of botanical families, genera, and species were calculated as well as their life-forms, collection sites, and edible plant parts. Following the approach of Buenavista et al. (2022), the food plants were classified based on FAO food use-categories modified from Kennedy et al. (2010): Cereals – includes corn, rice, or any other grains as well as products and foods derived from cereal crops (i.e., porridge, noodles, and other local foods); White roots and tubers, and plantains – this group include all non-grain-based, and non-pigmented starchy staples (i.e., cassavas, potatoes, and yams); Vitamin A-rich vegetables and tubers – this includes roots, tubers, and other yellow/red/orange vegetables (i.e., carrots and sweet potatoes). This group also include items botanically considered as fruits but locally used as vegetables in culinary use (i.e., squash); Green leafy vegetables – medium to dark green leafy vegetables (i.e., cabbage, spinach, and sweet potato leaves); Other vegetables – include all the non-leafy edibles such as eggplant, okra, tomato, and bamboo shoots; Vitamin A-rich fruits – include locally available dark yellow or orange fruits that are sources of Vitamin A (i.e., ripe mango and papaya). Other Fruits – this group includes various parts of a plant; leaves, stem, fruit, and flowers (i.e., durian, rambutan, and edible flowers of torch ginger); Legumes, nuts, and seeds – include beans, dried peas, lentils, nuts, or seeds (i.e., peanuts and mung bean), as well as products made from these; Spices, condiments, and beverages – include items commonly used in small quantities and mainly used to enhance the flavour of the dish (i.e., black peppers and garlic). This list may include many additional items, including various flavouring pastes and seeds, depending on local knowledge of their uses. Beverages such as coffee, tea, and alcoholic beverages are included in this group.

For quantitative ethnobotanical analysis, the Use-Report (UR), Use-Value (UV) index, Number of Uses (NU), and Fidelity Level (FL) were all calculated using the free statistical software R with the R package *ethnobotanyR* (Whitney, 2020). The Use-Report (UR) calculates the total reported uses of each species in all the use-categories by all respondents (Prance et al., 1987). The Use-Value index developed by (Phillips and Gentry, 1993) determines the relative importance of each species based on the formula: $UV = (\sum U_i)/n$, where U_i is the number of uses (counted based on use-category) mentioned by each respondent, and *n* equals the total number of respondents interviewed. The UV index determines the most widely used food plant species (highest UV) as well as the underutilized species (lowest UV index approaching 0). The UV index, however, cannot determine whether the species is used singly or for multiple purposes. As such, the Number of Uses (NU) per species was likewise determined by calculating the sum of all the use-categories for which a species was cited (Prance et al., 1987). The Fidelity Level (FL) percentage on the other hand identifies the central role of each reported food plant species as agreed upon by all the respondents (Quave and Pieroni, 2015). The FL % of each food plant species was expressed as the ratio of the total number of respondents who independently suggested the use of a species for a specific use-category (I_p) and the total number of respondents who mentioned the plant for any use irrespective of the use-category (I_u) (Friedman et al., 1986) calculated as $FL = (I_p/I_u) \times 100$.

Result and Discussion

Most of the participants were females (64.51%) whilst males account for 35.49%. In terms of education, more than half of the respondents (54.84%) reached the primary level, 29.03% had no formal education, 16.13% attended the secondary level. Nobody from the community attended college or the tertiary level (Table 1). The majority of the respondents are farmers (76.32%), one (2.63%) work as a teacher, and 8 (21.05%), have other jobs (i.e., laborer, etc.). Most of the interviewed households has a monthly income of 1000-5000 Php or $18.05-$90.24 ($1= 55.40 Php) per month (61.29%) (Table 1). The income of the Matigsalug-Manobo community is mainly derived from farming.

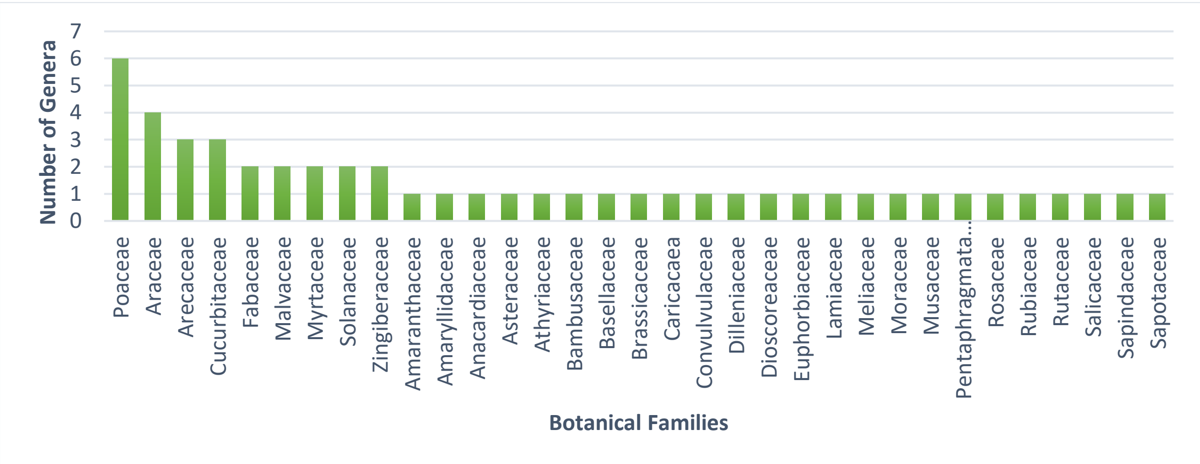
Table 1.
Demographic information of respondents (n=31) from Sinuda, Kitaotao, Bukidnon

Sex	
Male	11 (35.49%)
Female	20 (64.51%)
Education	
None	9 (29.03%)
Primary Level	17 (54.84%)
Secondary Level	5 (16.13%)
Tertiary Level	0 (0%)
Occupation	
Farmer	29 (76.32%)
Teacher	1 (2.63%)
Others	8 (21.05%)
Estimated Monthly Income	
Less than 1000 Php	0 (0%)
1000-5000 Php	19 (61.29%)
6000 – 10000 Php	10 (32.25%)
11000-15000 Php	1 (3.23%)
16000-20000	1 (3.23%)
>20000	

Botanical diversity of edible plants

A total of 62 species of edible plants belonging to 50 genera and 33 botanical families constitute the traditional food system of the Matigsalug-Manobo tribe (Figures 4 & 5). The botanical family yielding the highest number of edible plants was the family Poaceae (grass family) with six species.

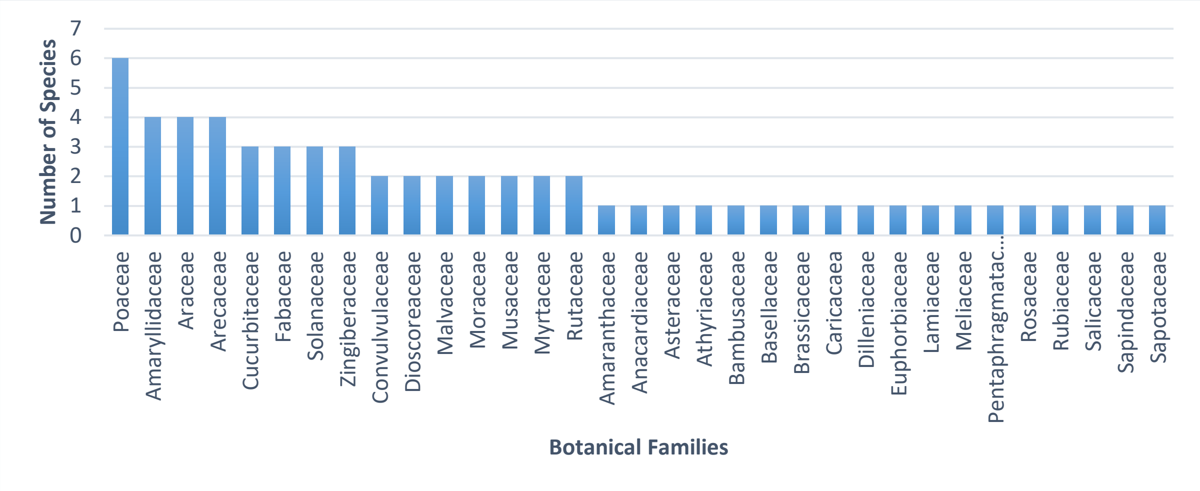
Figure 4.
Number of edible plant genera per botanical family



Other well-represented botanical families in the Matigsalug-Manobo food system include Araceae (arum family), Arecaceae (palm family), and Amaryllidaceae (amaryllis family), each with four species. This is followed by Cucurbitaceae (gourd family), Fabaceae (legumes), Solanaceae (nightshade family), and Zingiberaceae (gingers), each with three species.

Figure 5.

Number of edible plant species per botanical family



Quantitative ethnobotanical analysis

A total of 804 use-reports were accounted in all 9 FAO use-categories: 4 species (6.45%) were consumed as cereals, 6 species (9.67%) were white roots, tubers, and plantains, 2 species (3.22%) were Vitamin A-rich vegetables and tubers, 18 species (29.03%) were eaten as green leafy vegetables, 15 species (24.19%) were categorized as other vegetables, 3 species (4.83%) were Vitamin A-rich fruits, 28 species (45.16%) were considered as other fruits, 11 species (17.74%) were classified as legumes, nuts, and seeds, and 15 species (24.19%) were used as spices, condiments, and beverages (Figure 6).

A few species have multiple usages such as jackfruit which is cooked and eaten as a vegetable (Other vegetables category) aside from its edible fruits (Other fruits category) and seeds (Legumes, nuts, and seeds category); The pith of coconut trunk is cooked and eaten as a vegetable (Other vegetables category) aside from its edible fruits (Other fruits category). It is also the source of fermented coconut drinks (Beverage category).

The edible plant species with the highest use-reports (UR) and use-values (UV) (Figure 6) were *Ipomoea batatas* (L.) Lam. (UR=56; UV=1.80), *Manihot esculenta* Crantz (UR=56; UV=1.80), *Musa* species (UR=50; UV=1.61), *Colocasia esculenta* (L.) Schott. (UR=44; UV=1.41), *Cucurbita maxima* Duchesne (UR=42; UV=1.35), *Artocarpus heterophyllus* Lam. (UR=33; UV =1.06), *Sicyos edulis* Jacq. (UR=28; UV =0.90)

Most of the respondents have reported similar use(s) for the specific plant species with a fidelity level (FL) of 100% except for three species, namely, *Capsicum annuum* L. (chili), *Citrus microcarpa* Bunge., and *Cocos nucifera* L. In the case of *Cocos nucifera* L, all the key informants reported the utilization of its pith as vegetables as well as the direct consumption of its fruits (FL=100) but very few mentioned the use of coconut as an alcoholic beverage (FL=12.5).

In the Matigsalug-Manobo food system, Poaceae, Araceae, Arecaceae, Cucurbitaceae, Amaryllidaceae, Fabaceae, Solanaceae, and Zingiberaceae were the most species-rich group. This may be explained by the fact that the aforementioned botanical families were amongst the world's largest group of food plants. Plant families with many edible species, like Poaceae, is composed of 314 edible species worldwide whilst Fabaceae consisted of about 625 edible species (Antonelli et al., 2020). Aside from a variety of arums and palms, Solanaceae is also one of the major edible botanical family which includes some important staples such as potato, tomato, eggplant, and chili (Samuels, 2015). Several species of the ginger family Zingiberaceae are likewise domesticated and used as food (i.e., spices, flavoring agents, etc.) in many parts of the world (Rachkeeree et al., 2018). Cucurbitaceae on the other hand includes a large number of vegetables that are widely cultivated in many parts of the world (i.e., squash, chayote, bitter gourd, etc.) (Rolnik and Olas, 2020).

Figure 6.

Chord diagram showing the distribution of 804 use-reports (UR) for the 62 species of food plants (bottom half) utilized by the Matigsalug-Manobo tribe as cereals, white roots, tubers, and plantains, vitamin A-rich vegetables, green leafy vegetables, other vegetables, vitamin-A rich fruits, other fruits, legumes, nuts, and seeds, spices, condiments, and beverages (use-categories in the top half)

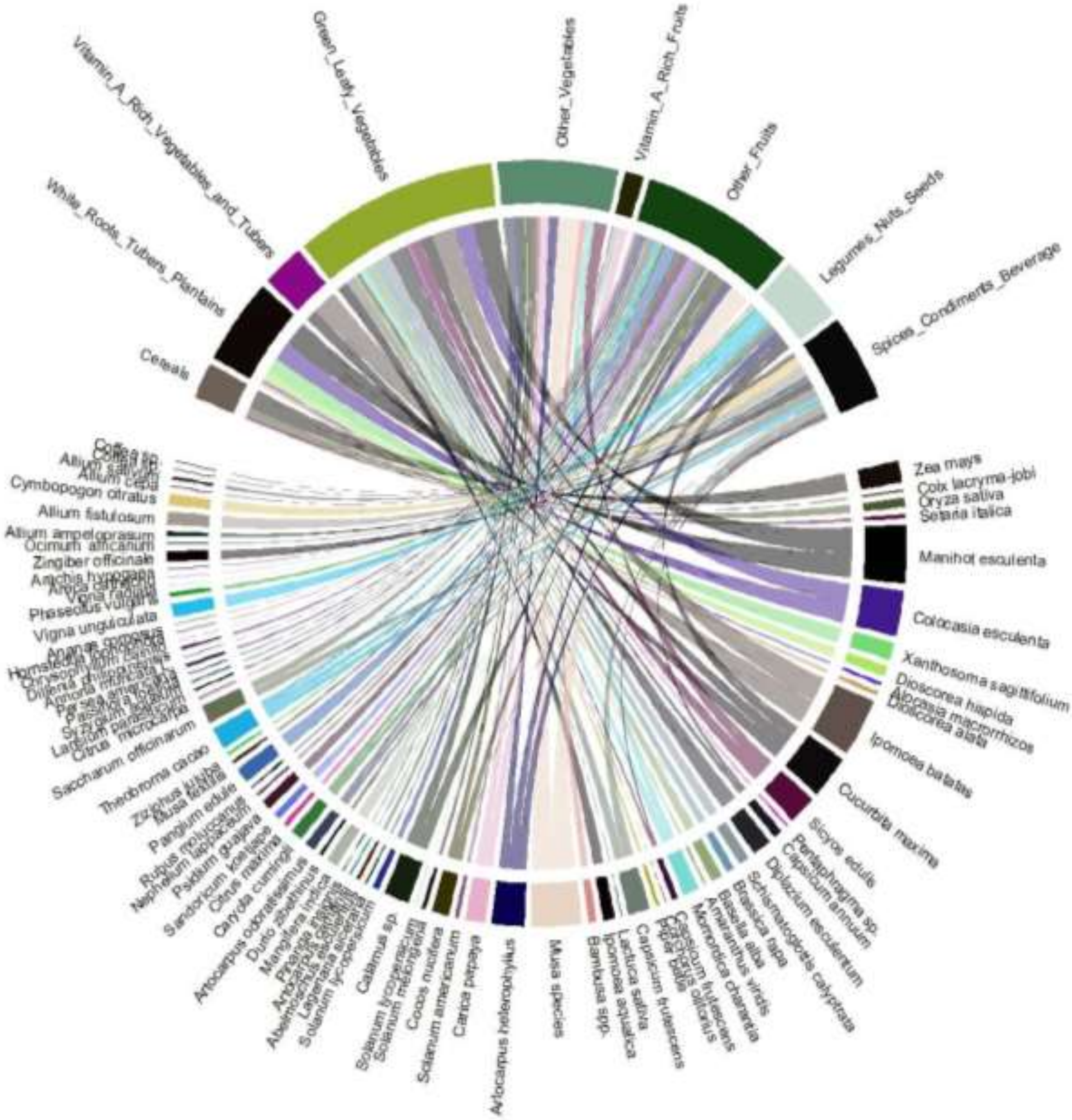
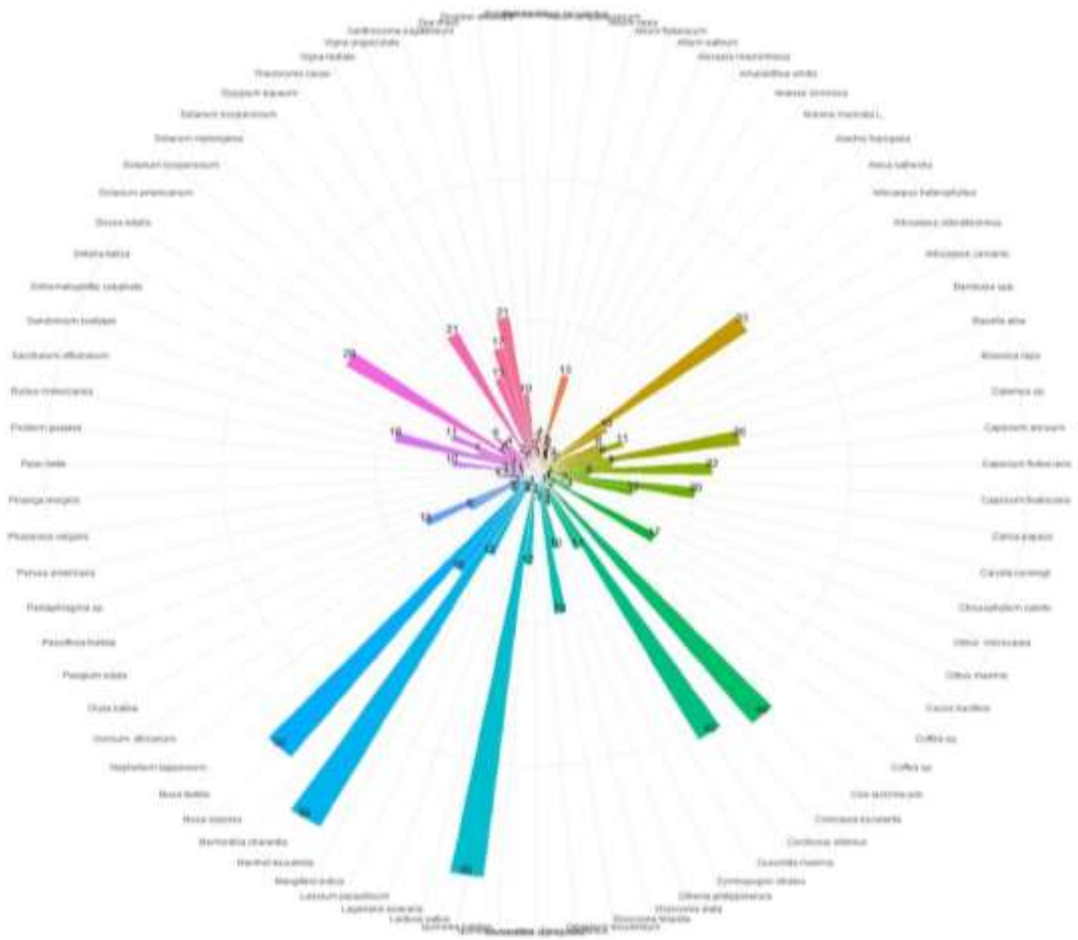


Figure 7.
Radial plot showing the use-report of the 62 species of food plant species. The species with the highest use-report have long rays in shades of blue (I. batatas (L.) Lam., M. esculenta Crantz, Musa species), green (C. esculenta (L.) Schott., Cucurbita maxima Duchesne), and red (Artocarpus heterophyllus Lam., Sicyos edulis Jacq.) whilst species with low use-values have shorter rays in shades of purple and yellow clustered in the centre



Although the Matigsalug-Manobo tribe are rice cultivator, some biocultural adaptations have been vital in the resilience of the indigenous communities with limited food resources. This includes the planting of sweet potatoes, bananas, cassava, and taro which provide alternative food sources. Apart from improving food security, diversifying our foods could also improve our agriculture to be more adaptable to climate change (Narciso and Nyström, 2020; Ulian et al., 2020). The Matigsalug-Manobo tribe's food system diversification consisting of different roots and tubers, plantains, vegetables, and fruits may be further explained by the mountainous terrain of Bukidnon province and the constraints of limited rice production in the uplands. Interestingly, the Matigsalug-Manobo tribe also tapped certain food plants that are often considered neglected and underutilized species. This include *Setaria italica* (L.) P. Beauv. or foxtail millet locally known as "dawa", *Coix lacryma-jobi* L. (Job's tears) or "uleybon", and even the toxic plant, *Pangium edule* Reinw. ex Blume is locally known as "pangi" which is traditionally processed to be eaten safely by the community.

Conclusion

As the Philippines continue to face the problem of rice shortage, The importance of ethnobotanical knowledge of food plants of the Matigsalug-Manobo tribe was explored in this study. The quantitative ethnobotanical analyses showed that the Matigsalug-Manobo's food system is composed of 62 species of edible plants belonging to 50 genera and 33 botanical families. A total of 804 use-reports were accounted in all 9 FAO use-categories: 4 species (6.45%) were consumed as cereals, 6 species (9.67%) were white roots, tubers, and plantains, 2 species (3.22%) were Vitamin A-rich vegetables and tubers, 18 species (29.03%) were eaten as green leafy vegetables, 15 species (24.19%) were categorized as other vegetables, 3 species (4.83%) were Vitamin A-rich fruits, 28 species (45.16%) were considered as other fruits, 11 species (17.74%) were classified as legumes, nuts, and seeds, and 15 species (24.19%) were used as spices, condiments, and beverages. Unlike the rice-centred diet of the majority of Filipinos, the Matigsalug-Manobo food system relies on diverse staples such as sweet potato, cassava, plantain, taro, and other cultivated and wild edible plants. Several plant resources along with the associated indigenous knowledge can be tapped to address the perennial problem of rice shortage and nutrient deficiency in the country. This approach could potentially contribute to the Philippines' commitment to achieving the Sustainable Development Goals on Zero Hunger.

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