

Species Diversity and The Importance of Charismatic Medicinal Plants in Ayer Hitam Utara Forest Reserve, Johor

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Abstract: Medicinal plants in peat swamp have not received much attention in Malaysia in recent years due to land conversion in this peat swamp area. This study aimed to record species diversity of medicinal plants in Ayer Hitam Utara Forest Reserve, to develop an interactive website containing medicinal plants in Ayer Hitam Utara Forest Reserve and to collect feedback on user experience using the website by using an online survey. Data about species diversity was measured by Shannon-Wiener Index by doing random sampling with 10 m x 5 m quadrat. There are 21 species (14 families) of medicinal plants were identified. *Clidemia hirta*, *Spondias dulcis* and *Vitex pinnata* were among the highest number of individuals of each species that could be found. Fever, wound treatment, and stomachache, were the most common illness that uses these medicinal plants. Decoction method was the most typical way to prepare this herbal medicine. *Koompassia excelsa* is one of the new records of medicinal plants found in this Ayer Hitam Utara Forest Reserve which can lower cardiovascular risk, act as an antioxidant and help in wound healing. An interactive website was developed using StoryMap ArcGIS to document the collection. Based on feedback for the website, most of the respondents agreed that the website has good content and user-friendly. This documentation is crucial to preserve our natural resources for the future generation.

Keywords: Ethnobotany, medicinal plants, peat swamp forest, traditional knowledge, documentation, digitization

1. Introduction

The use of medicinal plants is common throughout the world for thousands of years and still used as remedy for certain local communities [1]. Herbs, shrubs and trees are the many portions of this medicinal plant that are used to treat jaundice and other disorders such as inflammation, anthelmintic, and diuretic [2]. The usage of these medicinal plants was only restricted to rural areas and among the indigenous people in a certain area [3].

Peat swamp forests are terrestrial wetland ecosystems where organic matter production exceeds its decomposition and net accumulation results [4]. Furthermore, lowland peat swamp forest has contributed to indigenous peoples' way of life and economy by providing resources for food, shelter, medicine and cultural well-being. They may continue to provide long-term support to local communities for their socio-economy, but only if their characteristics are understood and they are managed in a sustainable manner [4].

Plants have historically provided various benefits to humans. Many plant species are used to treat illness and human well-being [5]. Around 2,000 plant species in Malaysia have therapeutic characteristics and can be used in traditional therapy [6]. According to [7], *Stenochlaena palustris* had the largest importance value (IV) in traditional knowledge which could be found in the burned area of peat swamp forest. This species usually can be found in peat swamp areas with open areas and the soil is rich in sulphate acid [6].

The study of medicinal plants in peat swamp has not received much attention in Malaysia in recent years due to massive land conversion within peat swamp reserves. This study looks at the diversity of medicinal plants in Ayer Hitam Utara Forest Reserve, the largest and last remaining peat swamp in Johor. Ayer Hitam Utara Forest Reserve is a

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mix of peat swamp, freshwater swamp and lowland evergreen forest. Besides, this study also applies the documentation method to document and preserve the potential medicinal plants in this forest reserve for the future. This documentation method was done using StoryMapArcGIS as an interactive website to gather all information about medicinal plants that had been found at the forest reserve. Feedback was collected to get user experience in using this website.

2. Methodology

2.1 Study Site

This study was conducted in Ayer Hitam Utara Forest Reserve, Johor. This forest reserve was categorized as Protected Area and also one of the largest and last remaining peat swamp forests in Johor [8]. It is a 3,965.84 hectares (ha) forest reserve in Muar district of Johor [8].



Fig. 1 - Map of Ayer Hitam Utara Forest Reserve [8]

2.2 Data Collection

2.2.1 Species Diversity

The study was conducted using quadrat sampling. Six plots, each size 10 m x 5 m where three plots at the lowland area and three plots at the peat swamp area. Data was gathered from each plot by random sampling. The collection of these medicinal plants started at the latitude of 2°3'3" N and longitude 102°49'39" E. Plants like shrubs, small trees and herbs were expected to have medicinal properties. All medicinal plants within the quadrat were collected, tagged and placed into specimen bags. The plant samples were then transported to Universiti Tun Hussein Onn Malaysia (UTHM) laboratory, where they are then pressed, dry mounted and curated into herbarium sheets. After all these specimens were collected and identified, they are documented on an interactive website.

2.2.2 Development Interactive Website

The interactive website was developed using a StoryMap ArcGIS which documents all medicinal plant that could be found in the forest reserve. The information on medicinal plants includes their local name, number of individuals, morphological characteristic of the plant, location of the plot and their traditional uses.

2.2.3 Feedback On the Website

From this interactive website, feedback was collected through an online survey. This online survey was divided into three parts which are the demographic part, knowledge about medicinal plants in North Ayer Hitam and feedback on the website itself. The data collection of this online survey was conducted in three days, with 80 respondents from UTHM students and staff.

2.3 Data Analysis

Data collected were used to calculate diversity and species richness of medicinal plants in six different plots in Ayer Hitam Utara Forest Reserve. In this study, the species diversity is characterized by using Shannon-Wiener Index (H') which is based on the abundance of the medicinal plants species in the location and is calculated using the formula of:

$$H' = - \sum p_i \ln p_i \quad (1)$$

Where, H' represents diversity index, p_i is the proportion of individuals of species and \ln represents natural logarithm.

Margalef Index (D_{Mg}) is used to count the number of individuals of each species distributed among the area and is calculated using the formula of:

$$D_{Mg} = \frac{S-1}{\ln N} \quad (2)$$







Where, D_{Mg} represents species richness index, S is number of species in an area and N represents total number of individuals.









3. Result and Discussion






3.1 Medicinal Plant Checklist









Throughout four days of the sampling period, 21 medicinal plants were successfully collected. The summary is shown in this Table 1.



Table 1 - Medicinal plants in Ayer Hitam Utara Forest Reserve

Plot	Scientific Name	Local Name	Family	Number of Individuals (n)	Photo
1 (Lowland Forest)	<i>Aquilaria malaccensis</i>	Gaharu	Thymelaeaceae	2	
	<i>Clidemia hirta</i>	Senduduk bulu	Melastomataceae	4	
	<i>Gironniera nervosa</i>	Hampas Tebu	Cannabaceae	2	
	<i>Goniothalamus</i> sp.	Mempisang	Annonaceae	3	
	<i>Koompassia excelsa</i>	Tualang	Fabaceae	4	
	<i>Licuala spinosa</i>	Palas duri	Areaceae	3	

	<i>Ochanostachys amentacea</i>	Petaling	Olacaceae	3	
	<i>Pternandra echinata</i>	Sial menahun	Melastomataceae	10	
	<i>Sonerila heterostemon</i>	Ati-ati gajah	Melastomataceae	1	
	<i>Spondias dulcis</i>	Kedondong	Anacardiaceae	12	
	<i>Syzygium papillosum</i>	Kelat paya	Myrtaceae	2	
	<i>Thottea grandiflora</i>	Hempedu beruang	Aristolochiaceae	4	
2 (Lowland Forest)	<i>Allomorpha alata</i>	Medang Lawang Jantan	Melastomataceae	7	
	<i>Gironniera nervosa</i>	Hampas Tebu	Cannabaceae	3	

	<i>Goniothalamus</i> sp.	Mempisang	Annonaceae	3	
	<i>Pternandra</i> <i>echinata</i>	Sial menahun	Melastomataceae	5	
	<i>Spondias</i> <i>dulcis</i>	Kedondong	Anacardiaceae	6	
	<i>Thottea</i> <i>grandiflora</i>	Hempedu beruang	Aristolochiaceae	3	
	<i>Vitex</i> <i>pinnata</i>	Leban tanduk	Lamiaceae	10	
3 (Lowland Forest)	<i>Allomorpha</i> <i>alata</i>	Medang Lawang Jantan	Melastomataceae	2	
	<i>Aquilaria</i> <i>malaccensis</i>	Gaharu	Thymelaeaceae	2	
	<i>Clidemia</i> <i>hirta</i>	Senduduk bulu	Melastomataceae	15	

	<i>Gironniera nervosa</i>	Hampas Tebu	Aristolochiaceae	1	
	<i>Goniothalamus</i> sp.	Mempisang	Annonaceae	3	
	<i>Koompassia excelsa</i>	Tualang	Fabaceae	8	
	<i>Licuala spinosa</i>	Palas duri	Arecaceae	2	
	<i>Peperomia pellucida</i>	Sirih Air	Piperaceae	5	
	<i>Sonerila heterostemon</i>	Ati-ati gajah	Melastomataceae	3	
	<i>Spondias dulcis</i>	Kedondong	Anacardiaceae	3	
	<i>Thottea grandiflora</i>	Hempedu beruang	Aristolochiaceae	2	
4 (Peat Swamp Forest)	<i>Adenanthera malayana</i>	Saga Daun Tajam	Fabaceae	4	

	<i>Pandanus</i> sp.	Pandan daun kecil	Pandanaceae	1	
	<i>Piper caninum</i>	Sirih hutan	Piperaceae	2	
	<i>Syzygium papillosum</i>	Kelat paya	Myrtaceae	3	
5 (Peat Swamp Forest)	<i>Areca catechu</i>	Pinang Merah	Arecaceae	1	
	<i>Macaranga gigantea</i>	Kubin	Euphorbiaceae	3	
	<i>Syzygium papillosum</i>	Kelat paya	Myrtaceae	3	
6 (Peat Swamp Forest)	<i>Adenanthera malayana</i>	Saga Daun Tajam	Fabaceae	5	
	<i>Macaranga hypoleuca</i>	Mahang Putih	Euphorbiaceae	3	
	<i>Pandanus</i> sp.	Pandan daun kecil	Pandanaceae	2	

Syzygium papillosum

Kelat paya

Myrtaceae

2



As shown in Table 1, a total of 21 species with 162 individuals were identified at Ayer Hitam Utara Forest Reserve, Johor. Identification of these medicinal plants was collected by the plot. The highest number of individuals of medicinal plants is Plot 1 with 50 individuals. There are 12 species identified in Plot 1 during this sampling. *Syzygium papillosum* is the most dominant species that could be found in most of the plot. A total of 10 individuals could be found overall in Plot 1, Plot 4, Plot 5, and Plot 6. According to [9], only hydrophytic trees like *Syzygium papillosum* can dominate this waterlogged condition of the forest. In Plot 1, it was near to the peat swamp forest area but Plot 4 until 6 were in peat swamp forest which was dominated by the waterlogged condition. So, the surrounding area is also why domination of certain species may occur in that area.

Table 2 - Medicinal plants species their uses and mode of administration

Species Name	Local Name	Habit	Part Used	Disease treated	Mode of administration	Source
<i>Adenanthera malayana</i>	Saga Daun Tajam	Tree	Bark, Leaves	Treat wounds	Decoction of leaves and bark as an antiseptic.	[10]
<i>Allomorphia alata</i>	Medang lawang jantan	Herb	Root	Stomachache	A decoction of root with leaves and stem	[11]
<i>Aquilaria malaccensis</i>	Gaharu	Tree	Bark	Diabetes	A decoction of the bark	[12]
<i>Areca catechu</i>	Pinang Merah	Palm	Fruit	Anti-aging, give energy	Eat the fruit raw	[13]
<i>Clidemia hirta</i>	Senduduk Bulu	Herb	Leaves	Heart burn	A decoction of leaves	[14]
<i>Gironniera nervosa</i>	Hampas Tebu	Tree	Root	Skin diseases	A root decoction	[10]
<i>Goniothalamus</i> sp.	Mempisang	Tree	Root, Leaves & Bark	Eliminate excessive gas Skin complaints	A decoction of the root is used to eliminate excess gas in the body. Pounded leaves and bark are used for skin complaints	[15]
<i>Koompassia excelsa</i>	Tualang	Tree	Leaves Tualang Honey	Cardiovascular risk Antioxidant, help in wound healing	Decoction of leaves to reduce cardiovascular risk. Drink raw or with hot water, the Tualang Honey is an antioxidant and help in the wound-healing process	[16]
<i>Licuala spinosa</i>	Palas Duri	Palm	Leaves	Dehydration	A decoction of the leaves	[14]
<i>Macaranga gigantea</i>	Kubin	Tree	Root bark	Diarrhea and dysentery	A decoction of root bark is used in the treatment of diarrhea and dysentery	[8]

<i>Macaranga hypoleuca</i>	Mahang Putih	Tree	Leaves	Febrifuge, expectorant and anti-spasmodic	A decoction of leaves is used	[8]
<i>Ochanostachys amentacea</i>	Petaling	Tree	Bark, Root	Fever Rheumatic fever	A decoction of bark used to treat fever A root paste and other herbs are applied at swollen joints to treat rheumatic fever	[9]
<i>Pandanus sp.</i>	Pandan daun kecil	Shrub	Leaves	Headache, earaches, liniment for rheumatic pain	Leaves are boiled and used as an essential oil to treat headaches, earaches and liniment for rheumatic pain	[19]
<i>Peperomia pellucida</i>	Sirih Air	Viner	Leaves	Rheumatism	A decoction of leaves	[10]
<i>Piper caninum</i>	Sirih Hutan	Viner	Leaves	Hoarseness, throat-ache	Drink a decoction with <i>Labisia pumila</i> roots to cure hoarseness and throat-ache.	[10]
<i>Pternandra echinata</i>	Sial Menahun	Tree	Leaves	Coughs and asthma	A decoction of pounded leaves with another plant to treat coughs and asthma	[8]
<i>Sonerila heterostemon</i>	Ati-ati Gajah	Herb	Root Leaves/root	Gripping pains in stomach after childbirth Icterus neonatorum (neonatal jaundice)	A decoction of root with turmeric is given for gripping pains in the stomach after childbirth. A decoction of leaves/root are used in baths or applications for neonatal jaundice	[18]
<i>Spondias dulcis</i>	Kedondong	Tree	Fruit	Tissue recovery and vitamin	Eat it raw or cooked	[19]
<i>Syzygium papillosum</i>	Kelat Paya	Tree	Leaves	Fever, stomachache	A decoction of leaves is good in treating fever and stomachache	[8]
<i>Thottea grandiflora</i>	Hempedu Beruang	Herb	Leaves	Afterbirth tonic, antifertility, pain killer, anti-inflammatory and snake bite antidote	A decoction of leaves is used	[20]
<i>Vitrex pinnata</i>	Leban	Tree	Bark, Leaves	Stomachache, fevers, wounds	A decoction of the bark is used to treat stomachache. A poultice of the leaves is used to treat fevers and wounds.	[21]

There are three species that were found to treat stomachache and fever using the decoction method (Table 2). *Allomorphia alata*, *Syzygium papillosum*, *Vitrex pinnata* are traditionally used stomachache using traditional knowledge [11] [8] [21]. *Ochanostachys amentacea*, *Syzygium papillosum*, *Vitrex pinnata* are other examples in treating stomachache by using the traditional knowledge [8] [21]. In most of treatment it usually leaves with the decoction method to treat certain diseases. According to [17], decoctions are the most effective and fastest way to absorb the medicine.

3.2 Species Diversity

The data collected was analyzed using Shannon-Wiener Index (H') and Margalef Index (D_{Mg}).

Table 3 - Species diversity by plot

Plot	Number of Individuals	Number of Species	Shannon-Wiener Index (H')	Margalef Index (D_{Mg})
Plot 1	50	12	2.242	2.812
Plot 2	37	7	1.844	1.662
Plot 3	46	11	2.045	2.612
Plot 4	10	4	1.416	1.303
Plot 5	7	3	1.001	1.028
Plot 6	12	4	1.314	1.207

Based on Table 3, the highest value of Shannon-Wiener Index (H') is in Plot 1, which is 2.242. This plot recorded 50 individuals of each species and 12 species. This plot has number of individuals compared to other plots. Higher values of H' signifies a more diverse area. It is likely that these populations can adapt to various conditions and disturbance [24].

According to Table 3, the highest D_{Mg} value is Plot 1 with 12 species and Plot 5 recorded the lowest D_{Mg} with three species. From the same table, Plot 1 have the highest species richness and Plot 5 have the lowest species richness.

3.3 Feedback On Website

An online survey was distributed to UTHM students and staff. The survey was divided to three parts namely Part A which is the demography part, Part B is knowledge on Ayer Hitam Utara Forest Reserve and medicinal plants and Part C is feedback on the website. This website available at <https://storymaps.arcgis.com/stories/c9390923f5964d8aafaded164b496d01>.



Fig. 2 - Website developed using StoryMap ArcGIS

3.3.1 Demography Part

Table 4 shows the summary from the questionnaire for Part A, the demography part. This demography part contains gender, age, highest academic qualification, category, roles, faculty, and year of the respondents. Table 4 shows that most of the respondents are female compared to males because females are willing to answer this online survey [25]. The total of students is much higher than the university staff due to a high number of students compared to the university staff and also younger age more preferred to answer online survey compared to older age [26]. Students from the author’s faculty were majority of the respondents compared to other faculty due to high targeted audience at that faculty.

Table 4 - Summary of demographic information of respondents

Information	Option	Total Number	Percentage (%)
Gender	Male	22	28
	Female	58	72
Age (years old)	18-26	69	86
	27-36	8	10
	37-46	2	3
	47 and above	1	1
Highest Academic Qualification	SPM	3	4
	Diploma	9	11
	Degree	61	76
	Master	3	4
	PHD	4	5
Category	Undergraduate	64	98
	Postgraduate	1	2
Roles	Student	65	81
	University Staff	15	19
Faculty	PPD	4	6
	FAST	42	65
	FTK	12	19
	FSKTM	1	2
	FKAAB	4	6
	FKMP	2	3
Year	Year 1	14	22
	Year 2	13	20
	Year 3	13	20
	Year 4	25	39

3.3.2 Knowledge About Ayer Hitam Utara Forest Reserve and Medicinal Plants

In Part B, there were several questions being asked for the respondents about their knowledge about North Ayer Hitam Forest Reserve and medicinal plants. Table 5 shows the summary of the result on Part B.

Table 5 - Summary about knowledge on North Ayer Hitam Forest Reserve and medicinal plants

Question	Option	Total Number	Percentage (%)
1. Do you know what a peat swamp forest is?	Yes	62	77
	No	18	23
2. Do you know that North Ayer Hitam is Peat Swamp Forest Reserve?	Yes	40	50
	No	40	50
3. Do you know that this North Ayer Hitam is a forest reserve?	Yes	48	60
	No	32	40
4. Based on the pictures below, which do you think is the medicinal plant?	Dedali (<i>Strombosi javanica</i>)	63	79
	Senduduk Bulu (<i>Clidemia Hirta</i>)	17	21

5. Have you seen this medicinal plant before?	Yes	56	79
	No	24	21
6. Do you think this plant is the same as the plant above?	Yes	44	55
	No	36	45

Table 5 shows that the respondents knowledge about Ayer Hitam Utara Forest Reserve were still low. Therefore, a good documentation on the uses of medicinal plants in Ayer Hitam Utara Forest Reserve is needed to increase the general public knowledge and awareness on the matter. There are several respondents who have knowledge on these medicinal plants compared to others who are not as familiar [26].

3.3.3 Feedback On the Website

For Part C, the questions were more focused on getting feedback on the website. It requires them to give their opinions and recommendations to make sure the information is well delivered to them. Table 6 shows the summary of the result on Part C.

Table 6 - Summary on feedback about medicinal plants in Ayer Hitam Utara Forest Reserve

Question	Option	Total Number	Percentage (%)
7. Do you like the design of this website?	Strongly agree	34	43
	Agree	38	48
	Neutral	8	10
	Disagree	0	0
	Strongly Disagree	0	0
8. Are you able to navigate to another section easily?	Strongly agree	36	45
	Agree	33	41
	Neutral	11	14
	Disagree	0	0
	Strongly Disagree	0	0
9. Do you find the content on this website relevant?	Strongly agree	40	50
	Agree	34	43
	Neutral	6	8
	Disagree	0	0
	Strongly Disagree	0	0
10. Does it take too long to load this website?	Strongly agree	22	28
	Agree	11	14
	Neutral	24	30
	Disagree	17	21
	Strongly Disagree	6	8

As shown in Table 6, most respondents like the design of the website, can navigate well, have good content, and are neutral for the time needed to load the website. They are familiar with using an interactive website prior to this survey so they expect a faster to load and easy to handle website while reading the information. There were 22 respondents (28%) who said that this website took a longer time to load because this website needs stable and strong internet connections to surf it.

Table 7 - Suggestions or comments to improve this website

Question	Answer
11. Do you have any suggestions or comments to improve this website?	<p>all good</p> <p>Maybe you can provide the medical uses of each medicinal plant stated in the website as an additional knowledge. <i>Use diagrams and mind maps to convey information</i> introduce more about medicinal and info</p> <p>Maybe the website can have more short clip on the plant or perhaps having some gifs to attract people more :) it is nice and simple no comment. <i>Do not use too many scientific words. Arrange the info and pictures in interesting way</i> Insert more information and facts <i>Everything is good</i> Put more realistic picture of plant less smartphone user friendly. Web-page not showing as nice as computer version. Able to load faster and smooth scrolling of page. Overall is very impressive. Need more information Varied the website(background) with more picture relevan <i>Add more information about medicinal plants</i> Take time to load the website</p> <p>This website is very interesting and may be added about the uses of the plant specifically such as the use of leaves, roots or examples of medicines made from the plant. <i>Add more informations related to plants</i> <i>Add more info from other countries about the medicinal plants</i> <i>No, everything is okay</i></p> <p>The pictures below maybe can be put in another section that we can choose. But overall, the website is quite interesting for us to scroll. Good job!</p> <p>Searching or discovery section can be opened for the users to search the relevant plant species by typing their scientific names or common names in the column or blank space provided for the section.</p> <p>Maybe can put choice of language because not everyone understands English. By doing that, we can receive more visitors to the website So far, the web easy use for everyone to excess Design improvement <i>It's all okay</i> Include more graphic Can make it bilingual in bahasa melayu and english. So far so good. <i>My internet is high speed right now, but when I open the website, it's a bit slow loading the pictures of the herbs</i> <i>Add the benefits of medicinal plants from pictures of that plants on this website</i></p> <p>Comment box for visitors to asks questions. Increases engagement. Can add more quiz on identifying the medical plants and the answer So far so good <i>It is better to include the uses/benefits of medicinal plants mentioned on the website</i></p> <p>Might give it a little more colour to make it merrier to the website. but after all, everything is great I love the simplicity you put in the website. good job for your work ^^ Yes, make a social media also</p>

I have no comment but what can I say, students especially science
base need to explore this website
The web needs attractive graphics so that it is not boring

Based on Table 7, the respondents gave their suggestions and recommendations on improving this website. Most of them stated that the design of the website should be improved by attaching more graphics and pictures of medicinal plants. Other than that, they also recommended putting more language choices to be able to reach a wider global audience. Respondents also mentioned that this website is useful for people, especially science students. Through these suggestions and recommendations, this website will be improved. Hopefully this effort will increase their interest in learning about medicinal plants and use it in their daily life.

4. Conclusion

This study showed that Ayer Hitam Utara Forest Reserve still has a population of potential medicinal plants. A total of 21 species under 14 families can be found at this study site. From the Shannon-Wiener Index, Plot 1 has the most species diversity compared to the other six plots. The collection of these medicinal plants will be converted into an interactive website for future use. Eighty respondents have viewed this interactive website comprising of UTHM students and staff, and most of them agreed on its usefulness.

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