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URBANIZATION AND LOSS OF MEDICINAL PLANT KNOWLEDGE: A CHALLENGE TO PRESERVING TRADITIONAL MEDICINE IN THE FUVAHMULAH CITY OF MALDIVES

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ABSTRACT

Plants are an important source of the human health care system. Around the globe, medicinal plants have been used to cure pain and other diseases. Likewise, traditional medicine in the Maldives relies heavily on locally grown plants. Urbanisation poses a huge threat to these plants and the knowledge of these plants remains with traditional medicinal practitioners. Since it is not extensively recorded, preserving this information is crucial for the continuity of traditional medicine. Thus, this research aims to document the medicinal plant species in Fuvahmulah City excluding wetland areas, to understand threatened and unthreatened medicinal plants, and to understand the reason for the decline and extinction of medicinal plants. This study adopted a qualitative research design. A purposive sampling method was used for the selection of participants, and data was collected through semi-structured interviews. The current study reported a total of 88 locally grown medicinal plants in Fuvahmulah excluding wetland areas. Including the additional 12 medicinal plants in the wetland areas of Fuvahmulah found by Fuvahmulah Nature Park (2021), a total of 100 medicinal plants can be found in Fuvahmulah. Among these 88 medicinal plants, 15% (13) of the medicinal plants are critically endangered, and 20% (18) of the plants are threatened or towards extinction. The remaining 65% (57) of the plants are unthreatened. The reasons for the decline and extinction of medicinal plants include lack of knowledge of medicinal plants of resident people, habitat destruction, degradation and fragmentation, plant disease, and climate change. Urgent conservation measures must be made to protect these plants and preserve traditional medicine.

Keywords: Medicinal Plants, Traditional Medicine, Conservation, Fuvahmulah City, Maldives

1. BACKGROUND

The Maldives has a rich tradition of local medicinal practices where practitioners have been using locally grown medicinal plants to heal people. According to the Ministry of Fisheries and Agriculture (1992), among the 583 species of plants in the Maldives, the highest diversity of species is in the medicinal plant group (more

than 300 species). These plants provide many benefits for human health, particularly in islands where the healthcare system is not well developed. Our forefathers used medicinal plants to cure diseases and till today, a lot of Maldivians believe that traditional medicine is always supposed to be safe as the medicines are made out of natural herbs. When conventional medicine did not work, many people considered traditional medicine. Today, a lot of challenges are there to preserve traditional medicine. The number of traditional healers in the Maldives is declining, and not more than 60 traditional healers exist across the country. Not much research has been conducted in the field of traditional medicine, especially with medicinal plants. Hence, the knowledge of traditional medicine remains with the healers. Medicinal plants in the Maldives are on extinction which in turn affects traditional medicine.

Traditional medicine is defined as native health practice techniques used to protect and regain health prior to the development of modern medicine (World Health Organisation, 2003). Medicinal plants are a vital part of the health care system for several countries and are a common ingredient of traditional medicine. It provides primary materia medica for 70 – 95 % of the citizens of most developing countries and is increasingly used by several people residing in wealthier countries (World Health Organization, 2002; Robinson & Zhang, 2011). A medicinal plant is considered as any plant that includes substances that can be utilized for therapeutic purposes or which are precursors for the manufacturing of drugs (Roy & Roy, 2016). Availability of medicinal plants may be lost through the reduction or loss of plant population. This problem exists around the world. Thus, it is important to protect and sustain the species of medicinal plants. The traditional medicine in the Maldives can be continued based on the assumption that these medicinal species will be always available. However, less effort has been made to ensure this.

Access to medicinal plants is expected to be threatened by several factors like climate change, perennial threats of direct anthropogenic habitat loss, and overharvesting (Applequist, et al., 2019). The extinction of plants leads to the loss of traditional knowledge (Live & Learn Environmental Education, 2010). The population of medicinal plants may be threatened by changing temperature and precipitation regimes, disruption of commensal relationships, and the increase of pests and pathogens, as well as anthropogenic habitat fragmentation that impedes migration (Applequist, et al., 2019). Several stakeholders found that there is a decline in the biodiversity of medicinal plants with implications for human health in the Maldives (Ministry of Environment and Energy, 2015). According to WHO (1993), threats posed to medicinal plants include high demand, increasing human population, and destruction of plant-rich habitats.

The Maldives consists of 1,190 small islands and the total area of the country is 90,000 Km². But only 1% of the country is land, which is 300 Km². Among these islands, 202 islands are inhabited, and because of the limited availability of cultivable land, agriculture plays a minor role in the economy. According to Sujanapal and Sankaran (2016), the ecological features of the islands in the Maldives vary from north to south, hence, vegetation also differs in different islands. Furthermore, these features differ between exterior and inner islands in different atolls as the former is more exposed to oceanic currents than the latter. These biological aspects are influenced by the characteristics of the foreshore area. The country's economy largely depends on tourism, and recently, traditional medicine has been incorporated into the tourism sector. Several resorts have started using medicinal species available from the islands and they have also started developing treatments in their spa (Kurumba Maldives, 2016). Thus, the sustainability of these plants is of utmost importance to protect the species from extinction. Due to the upward trend in population growth, societal changes, and fast pace of development, the medicinal plants in the Maldives are threatened by the destruction of their habitat, but detailed information on these plants is lacking in some areas and conservation action needs to be taken.

According to Live and Learn Environmental Education (2010), the southern islands of the Maldives have more plant diversity than the northern islands, but plant inventories are not well studied and documented. Fuvahmulah City, which is located in the southernmost region of the country, encompasses a variety of biodiversity within its coral, mangrove, and wetlands which are surrounded by marshes. This atoll is unique as it is the country's only single island administrative atoll because of its bowl form. Due to its unique ecological and geophysical form, Fuvahmulah stands alone against the vast expanse of the Indian Ocean. Therefore, the island is vulnerable to storm surges on both sides. However, it has developed its defence against storm surges by developing a high ridge of about 3m on the western side, and a little lower crest on the eastern side (Ministry of Environment and Energy, 2017). Geographically, the island is nearly flat, but there is a significant fluctuation in ground level in different areas. Fuvahmulah has a reasonably high outer ridge on all sides and low-lying inner areas. Some of the inner regions near the marsh are below the high tide mark. This island is one of the largest landmasses in the country and consists of agricultural lands with large marshy areas and swamps covered by freshwater lakes. These are possibly the only freshwater lakes in the country. This island is a habitat for many plants and animal species not to be found anywhere else in the Maldives.

The third largest population of the country resides in Fuvahmulah and the habitable land is around 300 Hectares. The current population is 9177 and the intercensal population growth rate of Fuvahmulah is 0.9%

from 2014 to 2022 (Maldives Bureau of Statistics, 2022). This Island has got the largest wetland in the Maldives that covers around 30% of the land (Ahmed & Faiz, 2017). Hence, excluding the wetland area, a smaller portion of the land is available as habitable area. Among these habitable areas, several areas are being utilised for socio economic infrastructure posing a threat to land availability. Compared to other islands of the country, the population density is very low in Fuvahmulah as it is 22 person per hectare excluding the wetland area (Ahmed & Faiz, 2017). The public has the opinion of reclaiming wetland areas to cater additional housing projects. This could be a threat for plants and animal species.

Fuvahmulah has been declared a United Nations Educational, Scientific and Cultural (UNESCO) Biosphere Reserve in the year 2020. This title was granted to promote methods that balance biodiversity conservation with its sustainable use. This international recognition sets up Fuvahmulah as a site for testing methods for sustainable management of natural systems that conserve biodiversity. Being declared as a biosphere reserve must ensure that environmental and cultural diversity are conserved for future generations. “There is a rich history within this biosphere reserve of traditional local medicinal practices” (UNESCO, 2020). Hence, sustaining medicinal plants is vital to passing traditional medicine to future generations. Several species grown in the marshes are used by the community for traditional medicine and other uses in Fuvahmulah (UNESCO, 2020).

It is evident from the traditional medicine practitioners that they use mostly medicinal plants that are available on their island to heal people (Saeed, 2008). Few books and catalogues of plants and medicinal plants that are available in the Maldives have been published (Sujanapal & Sankaran, 2016; Live & Learn Environmental Education, 2010; Ministry of Fisheries and Agriculture, 1992). Nevertheless, the medicinal plant inventory in the Maldives is incomplete, and medicinal plants available in separate islands have not been well studied. For most islands, there is not even a complete inventory of medicinal plants. A booklet of medicinal plants found in the wetlands of Fuvahmulah has been published by Fuvahmulah Nature Park (Fuvahmulah Nature Park, 2021). Yet, medicinal plants that are found in areas other than the wetlands of Fuvahmulah are unknown. According to Pimm (2020), there is a possibility that many plant species with a small range have vanished before taxonomists had a chance to describe them, thus, to prevent further extinctions, it is important to compile a catalogue of plants, where they live, and which species are threatened. Thus, this research seeks to compile an inventory of the medicinal plants found in Fuvahmulah other than in the wetland areas. More specifically the objectives of the study are: to identify the locally grown medicinal plants used in traditional medicine in Fuvahmulah, to identify the existing and threatened or endangered medicinal plants in Fuvahmulah, and to identify the reason for the decline and extinction of medicinal plants.

2. LITERATURE REVIEW

2.1 *Traditional Medicine System*

Before the advent of allopathic medicine in the 1930s, the primary health care of the country had been taken care of by traditional medicine. The traditional medicine system in the Maldives is unique in that it uses terrestrial as well as marine raw materials (Saleem, 2004). In the olden days, traditional healers used plants and parts of plants that were not grown locally. But later on, they found alternatives grown locally, making this another unique aspect of Maldivian traditional medicine. Although, it has been said that traditional medicine in the Maldives has been influenced by classical systems such as Ayurveda, Siddha, and Unani, the uniqueness of folk medicine remains (Saleem, 2004). Perhaps, this folklore medicine has been invented by Maldivians with their own experience and research, and it can be considered a heritage in the country. The knowledge of traditional medicine has been passed from generation to generation through hands-on training and experimentation instead of teaching from books (Solih, 2018). Marine organisms were also used in traditional medicine a long time ago, but their use is becoming less today. The main ingredient of traditional medicine is locally grown plants, and it is unique that this vegetation is very different from those found in other countries of the region. However, the knowledge of these plants and their medicinal values, preparation methodologies, and the technology they use remains with the healers. It is not well documented and conserving such knowledge is of utmost importance for the continuity of this unique intangible cultural heritage.

Researchers have highlighted that this traditional knowledge and practice may be lost in the future if proper actions are not taken in the Maldives (Saleem, 2004). Accordingly, Saleem (2004) detailed some of the threats to the conservation of traditional medicine: The country lacks awareness programs on the importance of traditional medicine and the importance of conserving medicinal plant habitats. Practitioners are not given any incentive to conserve and propagate plant species and disseminate the knowledge. Inadequate policies and regulations in this field and a lack of institutional capacity and coordination hinder the industry.

In recent years, there have been attempts to integrate traditional and modern medicine in the Maldives. In this regard, the government took steps in expanding and integrating traditional and complementary medicine

into the national health system. The national policy and law have been updated to accommodate this and the Maldives Board of Complementary Medicine has been formed under the Ministry of Health to register and regulate traditional and alternative medicine practitioners. The Maldives National University offered an Advanced Certificate in Traditional Medicine course. In addition, a training programme is available for indigenous traditional medicine practitioners. However, higher degrees are not offered yet and research in this field is rare. Moreover, a National Symposium on Traditional and Alternative Medicine was held in 2018. In the strategic plan for Biodiversity 2011-2020, a target focused on the conservation of traditional knowledge has been included. Following this target number 18, to conserve traditional medicine, an inventory of medicinal plants has been published (Ministry of Environment and Energy, 2015). Yet, the inventory is incomplete and it does not specify the list of medicinal species in different islands. Thus, it is important to identify the medicinal plants used in traditional medicine and the reasons for their extinction to conserve these species.

2.2 Endangerment of Plants

The extinction of plants poses a threat to other creatures, ecosystems, and human well-being, and must be studied to develop effective conservation measures (Humphreys et al., 2019). One in eight out of 270,000 plant species around the world are faced with the threat of extinction. The extinction of plants leads to the loss of traditional knowledge and wisdom among the citizens to safeguard the environment. According to Humphreys et al. (2019), almost 600 plant species have become extinct in the past 250 years. Some of these species have been rediscovered, but rediscovery is less likely in tropical islands, especially with a narrow range of species. This indicates that basic information about medicinal plants and their inventory is important to evaluate species loss and conserve it for the future.

Human impact on the environment is more visible than ever before, and it is increasing day by day. The main reasons for the extinction of plants include harvesting pressure, overexploitation, indiscriminate collection, uncontrolled deforestation, and habitat loss (Chen, et al., 2016). Pimm and Raven (2017) revealed that human activities such as habitat destruction, bringing plants and herbivores outside their native ranges, and anthropogenic climate changes are all putting plant diversity at risk. In addition, Islam et al. (2021) highlighted that plant species become endangered due to overexploitation, habitat loss and climate change.

The environment of this small island nation is extremely fragile to global environmental challenges. Climate change impact is evident where the natural habitats and biodiversity of Maldives islands are affected by cyclones, storms, and hurricanes (Sujanapal & Sankaran, 2016). According to the Ministry of Environment (2015), human settlement in the islands is the major cause of the decline in medicinal plant biodiversity through the degradation and destruction of native habitats and the introduction of invasive species. Some of the major invasive species found in the Maldives include *Prosopis juliflora*, *Lantana camara*, *Sphagneticola trilobata* and *Bidens pilosa*. In addition, disregard for traditional medicine is also a factor that leads to the decline of medicinal plants.

The only research that can be found in the traditional medicine area in the Maldives is a country report prepared by Saleem (2004). The major threat to the conservation of medicinal plants according to this report is habitat destruction, degradation and fragmentation, and unsustainable harvesting of these plants. As the country develops and as the population increases, there is a huge demand for land for housing, tourism development, road construction, harbour construction, and industrial activities. The original habitats of the plants would have been already destroyed in those islands where the population density is high. In addition, because of road construction, habitat fragmentation occurs which creates barriers to the normal dispersion and colonisation process of the wild population. When a large component of an island is utilised, many medicinal species will be declined due to the degradation of natural habitats. Intense exploitation of certain medicinal species would lead to a decline and the extinction of those species in the country. This would have a negative impact on traditional medicinal practice eventually leading to the decline of knowledge.

Today, the international community, as well as the local community are making efforts to lessen the threats to plants despite the challenges. The conservation strategies used are mainly of two different types: in situ conservation and ex situ conservation. In situ conservation is about harvesting plants in their natural habitat while ex situ is about maintenance of plant species outside their natural habitat. Natural reserves and wild nurseries are examples of in situ conservation, and botanical gardens and seed banks are examples of ex situ conservation.

3. METHOD

This exploratory study was conducted in Fuvahmulah City located in the southernmost region of Maldives. Figure 1 shows the geographical location of Fuvahmulah on the atoll reef and the natural shape of the island.

This study adopted a qualitative research design with semi-structured interviews. Traditional medicinal practitioners were identified from the booklet of medicinal plants found in the wetlands of Fuvahmulah, and by asking the old citizens and community leaders of the island. It was noted that currently, less than 15 practitioners exist on the island. Ethics approval was granted for this research from Department of Research and innovation of Zikura International College (ZIC-Z6-SR/2022/182). Purposive sampling was used in this study where traditional medicine practitioners were selected based on their experience in the field and their popularity among the citizens. The interviews were conducted until the data had been saturated. The researcher visited their homes and interviewed them using semi-structured questions. Before beginning, the purpose of the study and the criteria of Critically Endangered (CR) and Vulnerable (VU) plants as prescribed in the IUCN RED LIST Categories was explained to them (IUCN, 2012). Three main questions were asked: “what are the available medicinal plants from this island used in traditional medicine?”, “what are the critically endangered and vulnerable medicinal plants?”, and “what are the reasons for the decline and endangerment of medicinal plant species”. Most of the participants only know the local name of the plant. The people of Fuvahmulah use their own dialect to communicate, and as a result, they are unfamiliar with the Dhivehi names of these plants. Thus, it becomes a challenge to find the Dhivehi name and English name of the plant species. To identify the plant and find Dhivehi and English name of medicinal plants, several books, catalogues, booklets, and websites were searched and analysed (Fuvahmulah Nature Park, 2021; Sujanapal & Sankaran, 2016; Live & Learn Environmental Education, 2010; Ministry of Fisheries & Agriculture, 1992; Fuvahmulah Nature Park, 2021; Maldives Biodiversity, n.d.). Some English names of the species were found by using the google image search engine.

The data set has been analysed using Braun and Clarke (2006) theme analysis method. The data gathered has been transcribed and highlighted intriguing terms and expressions through a thorough analysis of the transcribed data.

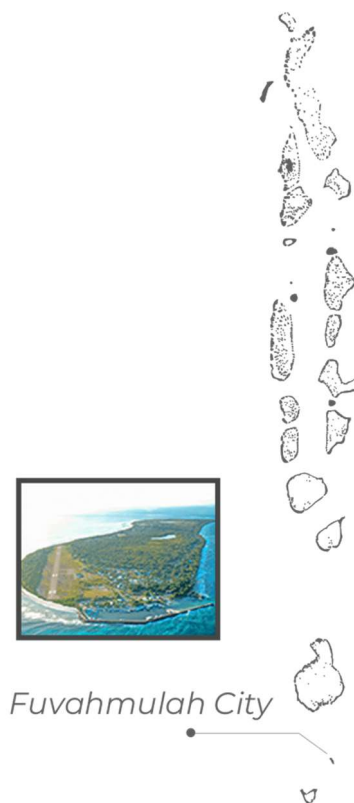


Figure 1: The geographical location of Fuvahmulah and a picture showing the natural shape of the island.

4. RESULTS AND DISCUSSION

4.1 Demographic Profile

Table 1 details the demographic profile of the participants. Five traditional medicine practitioners from Fuvahmulah participated in the interview. Among them are one male and four females, and all of them are above 50 years of age. Four of them are still practising, and one participant is above 70 years of age and retired.

All participants are citizens of Fuvahmulah, and all of them are having more than 20 years of experience in traditional medicine practice except one participant who has more than 10 years of experience. These practitioners have gained knowledge of traditional medicine from their family members, which is mostly inherited from their parents.

Table 1. Demographic Profile of the Participants

Participant	Gender	Age	Experience	Practising
1	Female	50 - 69	More than 20 years	Yes
2	Male	50 - 69	More than 10 years	Yes
3	Female	Above 70	More than 20 years	No
4	Female	50 - 69	More than 20 years	Yes
5	Female	50 - 69	More than 20 years	Yes

4.2 Medicinal Plants found in Fuvahmulah City

The medicinal plants identified from the collected interviews were collated into an inventory listing the local names of the plants, Dhivehi names, English names and Scientific or Botanical names. A total of 88 locally grown medicinal plants have been identified in Fuvahmulah. Among these, 14 plants are common in the catalogue of plants that are grown in the wetlands of Fuvahmulah. This may indicate that these plants can grow in both wetland areas, as well as on the other areas of the island. Table 2 details the name of the medicinal plants found in Fuvahmulah with its local name, Dhivehi name, English name, Scientific name, critically endangered plants, vulnerable plants and plants that are common in wetland areas. Despite several attempts, some plant species are left without their Dhivehi name, Common, or English name and Scientific name. Eight (8) plants are left without their Dhivehi name, six (6) plants are left without their English name, and seven (7) plants are left without their scientific / botanical name. Dhivehi and English names of four (4) plants were not identified.

Table 2. List of Medicinal Plants found in Fuvahmulah

	Local Name	Dhivehi Name	English Name	Scientific / Botanical Name	CR	VU	Common in Wetland Area
1	An'hi	An'hi	Noni, Cheese Fruit, Great Morinda, Indian Mulberry	<i>Morinda citrifolia</i>	-	-	Yes
2	Asirimal	Asurumaa	Four o'clock Flower, Marvel of Peru	<i>Mirabilis jalapa</i>	-	-	-
3	Asse thabere	Than'buru veyo, Assi'thanburu	Goat's Foot Creeper, Railroad Vine	<i>Ipomoea pes-caprae</i>	-	-	-
4	Bileiy	Bileiy	Betel	<i>Piper betle</i>	-	-	-
5	Bondi Ken'dhulhu	Maakandholhu	Seashore Lily, Bakung, Giant Crinum Lily, Asiatic Poison Lily, Spider Lily, Seashore Crinum	<i>Crinum asiaticum</i>	-	-	-
6	Boshi	Boshi	Tree heliotrope	<i>Tournefortia argentea / Messerschmidia argentea</i>	-	-	-
7	Dhadokiredhi	Kudhi-ruuvaali	Cape Sand Olive or <i>Dodonaea viscosa</i>	<i>Dodonaea viscosa / Dodonaea</i>	-	Yes	-

				<i>viscosa var angustifolia</i>			
8	Dhel meyvaa	Dhaagandu' kekuri	Wild Maracuja, Bush Passion Fruit, Marya-marya, Wild Water Lemon, Stinking Passion flower, Love-in-a-Mist or Running Pop	<i>Passiflora foetida</i>	-	-	-
9	Dhigi theyra	Dhigu thiyara	Coffee Senna, Negro Coffee	<i>Senna occidentalis</i>	-		Yes
10	Dhikkanaa		Birdbill Dayflower	<i>Commelina dianthifolia</i>	-	Yes	Yes
11	Dhiyabondolhi	Dhiyamudholhi	Bengal Spiderwort, Tropical Spiderwort, Bengal Day Flower	<i>Commelina benghalensis L.</i>	-	Yes	Yes
12	Dhon moosa	Dhonmoosa	Titberry	<i>Allophylus cobbe</i>	-	Yes	-
13	Dhoo hen'beri	Dhoo himeri	Wild Bean	<i>Phaseolus / Apios americana</i>	-	Yes	-
14	Dhunburi	Dhunburi	Cork Wood Tree	<i>Ochrosia borbonica</i>	-	-	-
15	Elhefelaa	Vepilla	Water Hyssop, Thyme Leaved Gratiola	<i>Bacopa monnieri</i>	-	-	Yes
16	Esheni	Ganjaa	India Hemp, Hashish, Marijuana	<i>Cannabis sativa</i>	Yes	-	-
17	Falhoe	Falhoe	Papaya, Papas, Papaw Tree	<i>Carica papaya</i>	-	-	-
18	Fen-foah	Fen-foah	Areca Palm, Betel Nut Palm, Pinang	<i>Areca catechu</i>	-	-	-
19	Finifenmal	Finifenmaa	Pinkrose (Rosa Polyantha)	<i>Rosa grandiflora</i>	-	-	-
20	Foni kunnaaru	Kunnaaru, Kashi kunnaaru	Jujube Tree, Indian Jujube, Indian Cherry	<i>Ziziphus mauritiana / Z. jujuba</i>	-	-	-
21	Foni loa dhili				Yes	-	-
22	Foni thelhaa	Foni thulhaa	Clove Basil, African Basil, Wild Basil	<i>Ocimum gratissimum</i>	-	-	-
23	Fonimal	Fonimaa	Indian Cork Tree, Jasmine Tree	<i>Millingtonia hortensis</i>	-	Yes	
24	Funa	Funa	Ball Nut, Alexandrian Laurel, Beauty Leaf, Dilo Oil Tree, Indian Laurel, Oil-nut Tree	<i>Calophyllum inophyllum</i>	-	-	-
25	Gadhabinfalaa	Gadhabinfaalha	Money Plant, Jade Plant, Golden Pothos, Hunters Robe, Ivy Arum, Solomon Islands Ivy, Taro Vine, Devils Vine, Devils Ivy	<i>Epipremnum aureum</i>	-	-	-
26	Gandha felaa	Gedha, Gandhaa fellaa	Common Purslane, Garden Purslane, Indian Purslane	<i>Ocimum basilicum</i>	-	-	-

27	Gan'dha kelhaa	Gan'dha koalhi	Sweet Basil	<i>Portulaca oleracea</i>	-	-	-
28	Gera gehe	Magoo	Sea Lettuce	<i>Scaevola taccada</i>	-	-	-
29	Githel Kuri	Githeyo Kuri	Graceful Pouzolzbush	<i>Pouzolzia zeylanica</i>	Yes	-	Yes
30	Gomashi	Gomashi	Lemon	<i>Citrus limonum</i> <i>Risso</i>	-	-	-
31	Goran	kullha'filaa	Launaea Sarmentosa	<i>Launaea sarmentosa</i>	-	-	-
32	Gul'hazaaro	Gul'hazaaru	Mexican Tuberosa, Pheasant's Eye, Narcissus	<i>Polianthes tuberosa L</i>	-	Yes	-
33	Gulhi henberi				-	-	-
34	Haagofesgo		Running Buffalo Clover	<i>Trifolium stoloniferum</i>	-	-	-
35	Halahela	Halaveli	Bay Cedar	<i>Suriana maritima</i>	-	-	-
36	Heenafaiy	Heena, Heenagas	Henna Plant, Egyptian Privet, Samphire	<i>Lawsonia inermis</i>	-	-	-
37	Helen beli	Helen beli	Tamarind Tree, Indian Date	<i>Tamarindus indica</i>	-	-	-
38	Hema hen'beri				Yes	-	-
39	Hema vathi		Virginiana Spiderworts	<i>Tradescantia virginiana</i>	-	-	Yes
40	Hih'thala	Hih'thala	Fiji Arrowroot, East Indies Arrowroot, Pia, Maldives Arrowroot	<i>Tacca pinnatifida</i>	-	Yes	-
41	Hithigehe	Hithigas	Indian Lilac, Margosa Tree, Neem, Nimbay, Pichumarda	<i>Azadirachta indica</i>	-	-	-
42	Hudhu hen'beri	Hudhu himeri			Yes	-	-
43	Huvan'dha gen'di	Huvagoh	Sweet flag grass	<i>Acorus calamus</i>	Yes	-	-
44	Huvandha kothan	Huvan'dhu kothan			Yes	-	-
45	Irebedheli	Vaifilaa, Kukulhu vaifilaa	Caracalla Seeds	<i>Gynandropsis gynandra</i>	-	Yes	-
46	Kaashifelaa				-	-	-
47	Kaasinjee	Kaasinjee	Oil Grass, Lemon Grass, West Indian Lemon Grass	<i>Cymbopogon nardus / syn. C. Exaltus</i>	-	-	-
48	Kafa	Kafa	Cotton	<i>Gossypium</i>	-	Yes	-
49	Kahana gen'di	Buran'dha gon'di, Bodu raalhu, Buran'dha, Buran'dha filaa	Pig Weed, Spreading Hog Weed, Hog Weed, Tar Vein	<i>Beorhaavia diffusa</i>	-	-	-
50	Kalhokalhlhaa	Kalhukalhlha	Devil's Backbone, Zigzag Plant, Jacob's Ladder	<i>Pedilanthus tithymaloides / Euphorbia tithymaloides</i>	-	-	-
51	Kandho	Kandhu, Mas kandhu	Lantern Tree	<i>Hernandia nymphaeifolia</i>	-	-	-

52	Kassuri, Kasthoori	Kasthoori	Musk Okra, Musk Mallow	<i>Abelmoschus moschatus</i>	Yes	-	Yes
53	Ken'dhulhu	Kan'dholhu	Spider Lily, Poison Bulb	<i>Crinum asiaticum</i>	-	-	-
54	Kirithana	Kiruthona	Asthma Herb, Garden Spurge, Snake Weed	<i>Euphobia hirta</i>	-	-	-
55	Kochchey faiy	Kochchey faiy	Billygoat's Weed, Appa Weed	<i>Ageratum conyzoides</i>	Yes	-	-
56	Kudheena	Kudheena	Pepper Mint	<i>Mentha spicata</i>	-	-	Yes
57	Kudhi hithi	Meyyalunboa	Gripe Weed, Shatterstone, Leaf Flower	<i>Phyllanthus leprocarpus</i>	-	Yes	-
58	Kudithelhaa	Kulhithulhaa, Kudithelhaa	Holy Basil, Mosquito Plant	<i>Ocimum inodorum Burm.f</i>	-	-	-
59	Lansi mul	Lansimoo	Khus-khus'grass	<i>Vetiveria zizanioides</i>	-	-	-
60	Laskelhe	Dhikkanfaiy	Climbing Dayflower	<i>Commelina diffusa</i>	-	-	Yes
61	Lika	Nika, Kirigas	Banyan Tree	<i>Ficus benghalensis</i>	-	Yes	-
62	Linboi	Lun'boa	Lime	<i>Citrus aurantifolia</i>	Yes	-	-
63	Maabulhaa	Maabulhaa	Velvetleaf	<i>Abutilon striatum</i>	-	-	-
64	Maalhos keyo	Maalhos keyo	Plantain Banana	<i>Musa × paradisiaca</i>	-	-	-
65	Maaniga, Maa hen'beri	Maanifaa	Jack-bean	<i>Canavalia ensiformis</i>	-	Yes	Yes
66	Madhoshi	Madhoshi	Circassian Tree, Coral Wood, Red Bead Tree	<i>Adenanthera gersenii</i>	-	Yes	-
67	Massaagu	Massaagu	Love-lies-bleeding	<i>Amaranthus edulis</i>	-	-	-
68	Meedhili	Gobu gas, Midhili gas, Madhu gas	Indian Almond Tree, Java Almond, Pacific Almond, Singapore Almond	<i>Myrobalanus catappa</i>	-	-	-
69	Meranga	Muranga gas	Ben Oil Tree, Drumstick Tree, Horseradish Tree	<i>Moringa moringa</i>	-	-	-
70	Mulooki Fay		China Grass, Ramie,	<i>Boehmeria nivea</i>	-	-	-
71	Muran'dha gen'di	Buran'dhagondi	Pigweed/Spreading hogweed/Hogweed	<i>Boerhavia adscendens</i>	Yes	-	-
72	Nika	Nika	Banyan Tree	<i>Ficus benghalensis L</i>	-	-	-
73	Niyandhuru	Niyandhuru	Citron	<i>Aurantium medicum</i>	-	Yes	-
74	On'bovah	En'boo	Yellow Plum, Wild Apricot	<i>Heymassoli spinosa Aubl., Ximenia aculeata Crantz</i>	-	Yes	-
75	Ono	Onu	Bamboo Grass	<i>Bambusa</i>	-	-	-
76	Raaruhi	Raaruhi	Lather Leaf	<i>Colubrina asiatica</i>	-	-	Yes

77	Ranuaraa	Ranauraa	Tanner's Cassia	<i>Cassia alata</i> <i>L.</i> , <i>Cassia</i> <i>bracteata L.f</i>	Yes	-	-
78	Rendi	Aamanaka	Castor Bean	<i>Cataputia</i> <i>major Ludw.</i> , <i>Croton</i> <i>spinosus L.</i>	-	-	-
79	Revi	Revi	Mustard		-	-	-
80	Ruh	Dhivehi ruh	Coconut	<i>Cocos nucifera</i> <i>L</i>	-	-	-
81	Thello Faiy	Thaafi limaa	Purple Heart Glory	<i>Ipomoea</i> <i>marginata</i> <i>(Desr.) Verdc.</i>	-	Yes	Yes
82	Thin thudu felaa	Hunigon'di filaa, Hiridhathi	Frog Fruit, Sawtooth Fogfruit, Turkey Tangle,	<i>Phyla</i> <i>nodiflora (L.)</i> <i>Greene</i>	-	-	-
83	Uh'dhandi	Ud'dhandi	Sugarcane	<i>Saccharum</i> <i>officinarum L</i>	-	-	-
84	Un'buli	Vela'buli	Love vine	<i>Cassytha</i> <i>filiformis L.</i>	-	-	-
85	Uni	Uni	Beach Gardenia	<i>Guettarda</i> <i>Speciosa</i>	-	-	-
86	Vaathelhaa	Raabeburi	Cleome Viscosa, Asian Spider Flower, Tick Weed	<i>Cleome viscosa</i> <i>L</i>	-	Yes	-
87	Vasho theyra	Vah'thiyara	Sickle Senna, Sickle Wild Sensitive Plant, Sickle Pod	<i>Senna tora (L.)</i> <i>Roxb.</i>	Yes	-	-
88	Vehafaru	Vehafuruh, Rubbudu Filaa	Whisk Fern	<i>Psilotum</i> <i>nudum (L.) P.</i> <i>Beauv.</i>	-	-	Yes
Total:					13	18	14

4.3 Decline and Extinction of Medicinal Plants

Around the world, plant extinction rates (Humphreys et al., 2019) are hundreds to thousands of times higher than diversification rates (De Vos et al., 2015). Fuvahmulah being an island with rich biological diversity has a lot of medicinal plants. However, as seen in Table 2, several plant species are classified as critically endangered or threatened with extinction. It was noted that those plants that are classified as critically endangered were mentioned as extinct plants by the participants. Nevertheless, the researcher decided to keep them as critically endangered as it is difficult to validate the information. Vulnerable plants are towards extinction. Details of the critically endangered plants and vulnerable plants can be seen in Table 2. As shown in Figure 2, 15% (13) of the medicinal plants found in Fuvahmulah is critically endangered, and 20% (18) of the plants are vulnerable or towards extinction. Hence, conservation actions need to be taken urgently to conserve these plants and preserve traditional medicine.

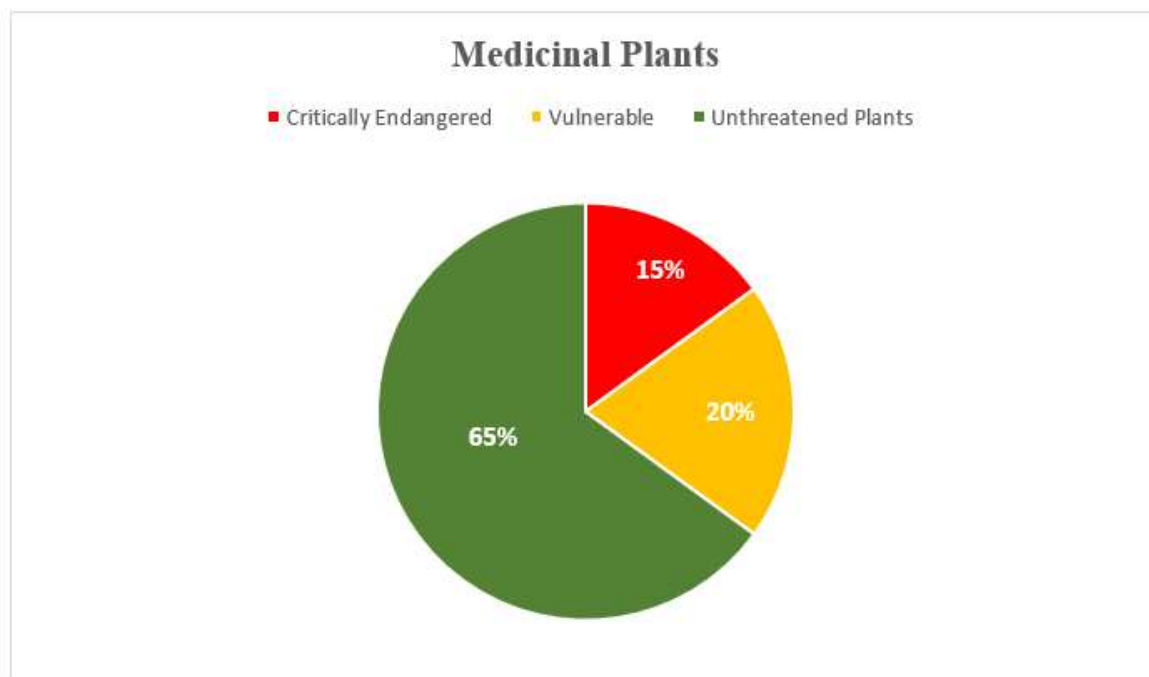


Figure 2 - A graphical representation of the critically endangered plants, Vulnerable plants and unthreatened plants in Fuvahmulah City

4.4 Reasons for the Decline and Extinction of Medicinal Plants

Four main themes have emerged from the participant's responses: lack of knowledge of plants, habitat destruction, degradation and fragmentation, plant disease, and climate change.

4.4.1 Lack of knowledge of plants. In the Maldives, the use of traditional medicine has been passed from family members to family members. However, the young generation has little interest in studying and understanding traditional medicine as well as medicinal plants. Thus, people have little or no knowledge about medicinal plants, thereby destroying these plants. Some of these medicinal plants are weed plants that can be grown and spread very easily. Thus, people consider it useless and they remove those plants. For instance, one participant said:

People consider these plants useless. They don't know the importance of these medicinal plants. Hence, they destroy it to keep their house clean (Participant 4).

Another participant mentioned:

The younger generation has no interest in learning traditional medicine. Most of these plants can be grown very easily and the spread is fast. Even if the plant is removed, after some time the trees regrow from those areas. But lack of knowledge of plants makes people remove them (Participant 5).

Despite the importance of medicinal plants for human health, the loss of cultural knowledge about plants and the disappearance of traditional medicinal practices has been widely reported around the globe (Vandebroek & Balick, 2012).

4.4.2 Habitat destruction, degradation and fragmentation. Loss of plant habitats in the Maldives is particularly associated with urbanisation and infrastructure development. Several terrestrial habitats have been lost to reclamation projects because of land scarcity in the country. As the country develops, human demand for biological resources such as space, goods, and amenities has risen to unprecedented levels (Ministry of Home Affairs Housing and Environment, 2002). In addition, habitat destruction due to housing and infrastructure development is a major issue for biodiversity conservation in the Maldives. Habitat degradation is also caused by the fast-growing population. When the population increases, people use more land for agriculture, industrial activities, and tourism development. Degradation causes nutrient depletion in the soil. Human development causes habitat fragmentation, as the forest areas are carved up for road construction. This creates a barrier to the normal dispersal and colonisation process of species. Habitat destruction, degradation,

and fragmentation alter the natural vegetation pattern and composition of the islands, thereby destroying the habitats of medicinal species.

Fuvahmulah has limited dryland because of its large expanse of wetland and marshy areas. Hence, the allocation of space for specific land use becomes a challenge. Most of the developments in Fuvahmulah are in accordance with the land-use plan which was developed in July 2019 by the City Council (Ministry of National Planning and Infrastructure, 2019). The main purpose of this land use plan was to sustainably develop the infrastructure in a way that is unharmed to the environment. According to this plan, only 23.2% of the land is available for future use. As the island develops, land has been used for road development and other infrastructure development. In the olden days (prior to 2000), most houses had garden areas and backyards where lots of plant species are grown. Some of the lands issued for housing were not even utilised in those days. Therefore, these unutilised lands contain lots of medicinal plants as they can be easily grown and spread. It has been more than 20 years since the government issued land plots for housing in Fuvahmulah (Fuvahmulah City Council, 2023). Hence, today most of the areas of their home are covered with buildings leading to habitat destruction of plants. This has been highlighted by the interviewees:

When we were young, most of the areas on the island were covered with trees and forests. Medicinal plants are easily available on the island, especially in the home garden and abandoned houses. But today, most of the lands are utilised. There isn't enough space for gardening and plantation (Participant 2).

To develop hospitals, airports, schools and other government buildings, land has been utilised. Hence, road development is required to use these facilities. Several roads have been developed and road construction is still ongoing. As most medicinal plants are like weeds, these species have been destroyed because of this (Participant 4).

Developing the city means more damage to the habitat of medicinal plants. Recently in March 2022, the government decided to commence several development projects including the expansion of the airport, construction of additional housing units, road construction, and construction of a 50-bed hospital. This year, The Fuvahmulah City Council decided to lease land for agriculture purposes to expand the agricultural sector as well. This could mean that a lot of medicinal plant habitats are in danger.

Furthermore, local tourism is expanding at a high speed on the island where land has been utilised for developing guest houses. Fuvahmulah being declared as a Biosphere reserve is reliant largely on its tourism and fisheries. For instance, one participant commented:

The government has decided to expand local tourism in Fuvahmulah. Those people who have settled their life in other islands and countries started leasing and developing their homeland as a guest house which destroys several plant species (Participant 1).

This problem of habitat destruction exists around the world. Human actions, especially habitat destruction and fragmentation, have put wild plant populations in jeopardy all over the world (Applequist, et al., 2019). More extinction will be experienced if the loss of natural habitats around the globe does not slow down (Ceballos, Ehrlich, & Dirzo, 2017).

4.4.3 Plant Disease. Plant disease is common everywhere in the world (Ristaino, et al., 2021), and it was found to be a cause of the extinction of plants in Fuvahmulah. Plant disease is referred to as the continuous and prolonged phytopathogenic organisms that cause abnormal physiological functioning of a plant (Tampakaki, Hatziloukas, & Panopoulos, 2009). Plant disease affects the growth and existence of plants. According to Tampakaki, Hatziloukas, and Panopoulos (2009), plant diseases create damage to localised tissue, and sometimes lead to the death of the plant. Occasionally, plants overreact to infections by pathogens thereby killing the whole plant. Thus, this aids pathogens to slow down the growth of plants and damages the plant. Almost all participants of the research emphasised plant disease affecting the growth of medicinal plants. For instance, one participant commented:

Because it is difficult to find medicinal plants, I tried to grow them at home. After some time, plants get a disease and it dies. Maybe it is because of climate change. The monsoon has changed a lot (Participant 5).

Diseases, pests, climate change, and other ever-changing pressures all weaken the stability of plants including medicinal plants (Roberson, 2008). Despite significant global investments to control plant diseases, annually about 10% of crop yield is lost due to plant diseases (Moo-Young, 2011).

4.4.4 Climate change. Climate change poses substantial effects on the environment and is considered one of the greatest challenges to social and economic development, especially for small island nations like the Maldives (Ministry of Environment and Energy, 2016). Climate change, habitat loss, overexploitation of

natural resources, and the introduction of invasive species are the effects of humankind on the environment (Live & Learn Environmental Education, 2010). Climate change threatens the Maldives on multiple fronts due to sea-level rise, ocean acidification, increasing air and sea surface temperatures, and changes in rainfall patterns (MWH, 2005). Furthermore, MWH (2005), anticipated that climate change will have adverse effects on the economy and the society of the Maldives as most of the economic activities rely on the coastal ecosystem. Henceforth, climate change will have negative effects on the species of medicinal plants.

Fuvahmulah, a unique island, also experiences several climate change factors such as heavy rainfall (The World Bank, 2018). In this regard, the island has experienced discrete, extreme events such as flooding because of heavy rain and/or storm surges within the last decade (Mohamed, King, & Cottrell, 2020). In addition, drought, coastal erosion, and an increase in temperature for a long period have been experienced as well. The cause of climate change was linked to global climate change with the frequency of extreme weather events. According to Maldives Meteorological Service (2021), the average temperature of the Maldives ranges from 25°C to 32°C, but the temperature was above normal and rainfall was below normal in all the areas of the Maldives during the month of June 2021. This shows that there is fluctuation in temperature across the country, validating what the participants of this research mentioned. Though flooding due to heavy rainfall occurred as decadal events in the past, it is now experienced in Fuvahmulah once every two years (Mohamed, King, & Cottrell, 2020). Fuvahmulah being one of the southernmost atolls, experiences more rainfall making them more vulnerable to flooding. (Ministry of Environment and Energy, 2016). Residents of Fuvahmulah considered coastal erosion the most serious climate change-related environmental issue, and it has been ongoing since the 1980s, but it got worse after the construction of the harbour in 2007 (Mohamed, King, & Cottrell, 2020). In addition, as per the perception of the people of Fuvahmulah, climate change and coastal destabilisation cumulatively influences erosion severity. Coastal erosion may affect the habitat of several medicinal species like sea lettuce, beach gardenia, Tree heliotrope etc. that grows in the coastal areas (Garner, et al., 2015).

The majority of the participants agreed that climate change is a reason for the decline of medicinal plants. Participants shared their experience with climate change, saying:

In the olden days, weather patterns were quite accurate and predictable, but today we experience prolonged high temperatures, heavy rainfalls, and coastal erosion is uncontrollable. These unpredicted weather conditions affect medicinal plant growth (Participant 3).

We can't bear the heat now because of the high temperature, so how will the plants be able to survive? Now we see extreme weather patterns. Maybe because of that pathogens attack medicinal plants and destroy them. What I can see is the leaves of medicinal plants get damaged and it stops growing (Participant 1).

Scientists have warned that around the world, climate change may threaten access to medicinal plants because of the decrease in available plant species and the extinction of species (Applequist, et al., 2019).

These findings are supported by Islam, et al. (2021), Pimm (2020), Applequist, et al. (2019), Ministry of Environment and Energy (2015), and Saleem (2004). According to these researchers, human activities lead to the extinction of plants which includes the destruction of habitats, degradation, fragmentation, unsustainable harvesting, over-exploitation, the introduction of invasive species, and climate change. Lack of knowledge on the medicinal plant as a factor that affects the reduction of medicinal plants has been supported by Vandebroek and Balick (2012). Among these factors that affect the reduction of medicinal plant population, unsustainable harvesting or overexploitation and the introduction of invasive species were not mentioned by the participants. However, Saleem (2004) found unsustainable harvesting as a threat to medicinal plants in the Maldives. Also, Live and Learn Environmental Education (2010) and Sujanalal and Sankaran (2016) revealed that invasive plants pose threats to the natural ecosystem in the Maldives. These factors not being identified as a threat to medicinal plants could be due to fewer people going for traditional medicine as the practitioners will have to find these species once in a while. Moreover, most of the medicinal plants are weed plants and they can be found somewhere on the island. In addition, if the practitioners are not gardeners, they may not be able to notice invasive species as well.

5. CONCLUSION AND RECOMMENDATIONS

This research project is an attempt to preserve traditional medicinal knowledge for future generations by identifying locally grown medicinal plants used in traditional medicine in Fuvahmulah City, identifying the critically endangered and vulnerable medicinal plant species, and understanding the reasons for the decline and endangerment of medicinal plant species. With the help of local traditional medicinal practitioners' indigenous knowledge, a total of 88 medicinal plants have been identified. Other than these plants, 12 other medicinal plants can be found in wetland areas of the Fuvahmulah (Fuvahmulah Nature Park, 2021). Hence, a total of 100 medicinal plants can be found in Fuvahmulah. Due to a lack of knowledge of medicinal plants of resident people, habitat destruction, degradation and fragmentation, plant disease, and climate change, 13 medicinal plants were critically endangered, and 18 plants were vulnerable and therefore threatened with extinction.

As 35% of medicinal plants found in Fuvahmulah are under threat, it requires rapid conservation measures. Then only we can prevent the loss of biodiversity and traditional knowledge and pass this resource to the next generation. It is important to create awareness programs on medicinal plants for the public. In addition, it is also important to take action to prevent and manage plant diseases.

This research provides baseline information on medicinal plants for further exploration. Documenting the medicinal plants with their photograph, local name, Dhivehi name, English name, and scientific name is required for easy identification. In addition, the classification of medicinal plants, their medicinal use, plant parts used, and preparation method is also required to be documented. Moreover, a toxicity study of medicinal plants is also required as some patients may experience toxic reactions to some plants. It is as well important to identify and validate the extinct plants as per IUCN Red List categories. A booklet of medicinal plants found in the wetlands of Fuvahmulah has been published and a medicinal plant nursery has been established to restore the plants by the Fuvahmulah Nature Park. This type of work has to be created for other medicinal plants as well. Without medicinal plants, traditional medicine cannot be continued. Already loss of biodiversity-based cultural knowledge has been reported globally (Vandebroek & Balick, 2012). If proper actions can be taken, this intangible cultural heritage can be saved from extinction with the passing of indigenous knowledge holders.

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