Vocal to local: indigenous dietary practices and diversity of wild food plants in Malai Mahadeswara wildlife sanctuary, South India

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Research

Abstract

Background: The voice of the indigenous food system on locally available wild food plants and consumption is an important strategy to sustain interrelated food problems of malnutrition and disease.

Methods: The study assessed the importance of wild food plant use among the forest-dwelling communities. Community perceptions were used to assess the patterns of use and interrelations of human well-being. Data was collected through a combination of semi-structured interviews, household surveys, and focus group discussions in eight villages. Local communities use wild plant species as food, therapeutic practices, and as a symbol of ethnic identity.

Results: The taxonomical distribution and diversity of 126 species belonging to 94 genera and 58 families have been assessed. About 83% of wild leaves as greens fall in the category of weeds. There were 15 species WFPs that have been shared with neighbours in the village, close relatives, or friends. More than 28 species of leafy vegetables are used by 80% of households for more than 20 days a year. The local communities also use 120 wild edible herbs and root species in ethno-medicine. *Boerhavia diffusa*, *Acacia farnesiana*, and *Alternanthera sissilis* have been used frequently as vegetables, they were reported to reduce blood pressure, increase iron in the blood, and improve eyesight.

Conclusions: The study emphasizes the dependency on the local food source and its livelihood importance. The study would help to evaluate the potential of WFPs use as future food in indigenous dietary systems and therapeutic practices.

Keywords: Indigenous food system, dietary diversity, therapeutic value, wild food plants

Background

Indigenous dietary practices have developed and are driven by the availability of local food resources since human civilizations across the world (FAO 2014). Particularly the use of local plant resources is a remarkable artifact of human society. Similarly, the local wild plants played a significant role in the evolution of diet and therapeutic practice in human history (Santayana *et al.* 2005). As the world is experiencing uncertainties due to climate change,

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food security, and better health which are the primary concern for the present and future human wellbeing (MEA 2005). Moreover, frequent catastrophic events, rising environmental issues, and the socio-economic crisis has led to acknowledging the importance of indigenous knowledge and practices as a better resilient strategy for the near future. (Shumsky *et al.* 2014). One such knowledge is the use of wild food plants (WFPs) which are most neglected and not recognized in any of the state assessments in India (Bharucha and Pretty 2010; Sundriyal *et al.* 2004; Jahnovi and Brahma, 2016).

The indigenous food system and therapeutic use of WFPs have evolved over many generations by the influence of uncertainty and problem-driven adaptive mechanisms and playing a major role as a medicinal food (Jain 1991). However, it is a vital element of the forest-dwelling community across the globe and social capital to produce food, health, practices can provide ecosystem services and help in understanding socio-ecological and adaptive management systems (Hamilton *et al.* 2016; FAO 2014). In India, the policies such as the Biological Diversity Act, 2002; Forest Rights Act, 2006, and Intellectual Property Rights have been emerging for possessing Traditional Ecological Knowledge (TEK). Perhaps, the Traditional Knowledge Digital Library (TKDL) aspires to prepare a document to protect and promote TEK and indigenous cultural practices. But the very little impact has been seen on the ground (Pathak 2000; Kalpavriksh 2008).

Dietary diversity: The WFPs are the key sources of indigenous food and constitute the bedrock of the dietary diversity of the forest-dependent communities across the globe (Santayana *et al.* 2005; FAO 2014). Dietary diversity practices are also well evident in the indigenous food system. Dietary diversity is defined as the number of either food items or food groups consumed by an individual or household in a given period (Godfray *et al.* 2010; Agea *et al.* 2011; Muller and Almedom 2008). Theoretically, greater dietary diversity increases the likelihood of consuming adequate amounts of all food components essential to health (Ogle *et al.* 2001; Godfray *et al.* 2010; Jose *et al.* 2014). Many studies also revealed that dietary diversity practices in the indigenous food system are the most common adaptive mechanism that served as therapeutic ailments or medicine to many common diseases (Dovie *et al.* 2007).

Sharing practices: Food sharing is another characteristic of the indigenous food system, and it is well documented across the world. These pro-social interactions influence the welfare of the community and also encouraged as social and ethical obligations (Agea *et al.* 2011). Food sharing has traditionally been considered a characteristic feature of human societies and morality since early hominids to modern humans, and from hunting and gathering to agriculture practice (Agea *et al.* 2012). Share web is a social network that serves as a safety net at any point of time exchange WFPs between family, household, relatives, and community levels. Sharing the resource and information has been identified as a long-term strategy to balance and manage risk in the traditional knowledge system (Madegowda *et al.* 2014; Krishnamurthy *et al.* 2015). Also, sharing culture has been practiced as a resilient adaptive strategy during the economic crisis of households and environmental crises like drought and floods.

Medicinal use: Traditional foods are the most important source of therapeutic use for nearly 80% of the developing world population (Muller and Almedom 2008). Many of the WFPs that are included in local food baskets have both therapeutic and dietary functions. Such medicinal foods have been part of traditional health practices since ancient times. The continued and synchronized uses of WFPs as foods and medicines in the households of local communities' flags as an example of better resilient adaptation for an undefined future. Some of the WFPs and practices are even more important to control chronic diseases like cancer, diabetes, and blood pressure (Rathod and Valvi 2011). Many countries like Africa, south-East Asia, and particularly the North-eastern regions of India have climatic and agro-ecological diversity which provided a foundation for rich traditional medicine and diverse use of WFPs (Ogle *et al.* 2001; Stephanie *et al.* 2014). Developed countries like the USA and Europe have recently recognized WFPs as potential sources of functional foods, nutraceuticals, and phytonutrients (Jose *et al.* 2017). Therefore, it is important to pay attention to traditional foods for several reasons such as their direct nutritional contribution is often significant but neglected (Puri *et al.* 2015; Sansanelli and Tassoni 2014).

Multi-functionality: Many studies found that the multi-functionality of WFPs; one-third of the plants have therapeutic roles, more than forty percent were used also as livestock feeds and one fifth was used as raw material for shelter, as ingredients for organic pesticide or insecticide preparation, and as agriculture tools (Rathore 2009; Bharucha and Prety 2010). Moreover, WFPs are the locally available source, capable of surviving during long droughts and growing in the wild. However, the achievement of zero hunger by 2030, adapting technology in agriculture, and crop intensification obscures the sustainability of the future (Muller and Almedom 2008). At a given rate of growth of the human population on earth and climate change uncertainty would undermine the food and

health security soon (Godfray *et al.* 2010; Castro and Espinosa 2015). Therefore, the indigenous system of WFP's use could be a better option to address food and health issues.

In the study area, local communities such as Soliga and Bedagampana depend on WFPs resources, which have been a part of their diet. The WFPs are not only a substitute for crops during the lean period, but also socio-cultural identity and practices evolved over generations; provide a link to their history, ancestors' land, and environmental philosophy (Harisha *et al.* 2015; Madegowda 2009; Shaanker *et al.* 2004). However, WFPs are ignored in economic and livelihood valuation, and there is a huge gap in understanding the local people's diet dependency on WFPs (Harisha *et al.* 2013). At the same time, local people are in turmoil by the multiple rules and regulations on wild resources a cause of concern for the erosion of indigenous knowledge (Harisha *et al.* 2015). Moreover, the limited information available regarding indigenous knowledge on WFPs use, dietary practices, and therapeutic applications remain absent in the policy framework (Madegowda *et al.* 2014). Therefore, the study was conducted in eight villages to investigate the place, role, and importance of WFPs in forest-dwelling households. The study aims to evaluate the potential of WFPs use as future food in indigenous dietary systems and therapeutic practices.

Materials and methods

Study site

The study has conducted in Malai Mahadeshwara (MM) Hills, located in South India, between latitude 12˚ 13' and 11˚ 55' N and 77˚ 30' and 77˚ 47'E (Figure 1). It is located in the southern tropical dry zone topography and mountainous north-south trending hill ranges of the Eastern Ghats. The sanctuary covers an area of 906.2 km² and has an undulating terrain and mosaic habitat. MM Hills possesses extensive forests and a chain of mountain peaks with elevations ranging from 600-1480 m.

The climate of MM Hills is quite moderate throughout the year with hot summer and cold winter. The mean annual temperature in the study area is 35.3˚C and varies between 24˚C in winter to 42˚C in summer (Indian Meteorological Data 2016). It receives rain from the southwest monsoon between May-August and from the northeast monsoon between September-December with a pronounced dry period between January and March. There is considerable variation in rainfall with topography and the average annual rainfall is 948mm. However, most of the rain is derived from the northeast monsoon during September-November.

The forest possesses a large variety of medicinal herbs used by local people in traditional healthcare, cultural, and religious systems. However, these forests are subjected to many anthropogenic activities including agriculture, pilgrimage, quarrying, collection of minor forest produce and fuelwood, and other developmental activities (Shaanker *et al.* 2004; Aravind *et al.* 2010). Despite tremendous anthropogenic pressure, the area is rich in biodiversity with 800 species of higher plants (Champion & Seth 1968). It has different forest types such as dry deciduous (64.34%), scrub woodland (20.50%), and scattered patches of moist deciduous and riparian forest (2.47%) (Champion & Seth 1968).

Communities

There are 31 settlements (villages) scattered within and at the periphery of MM Hills forest. About 8 villages constitute a homogeneous community called Soligas; whereas another 23 villages are constituted of heterogeneous communities called Soliga and also Bedagampana. Soligas are the indigenous tribes living in MM Hills forest for centuries and they have historically been engaged in hunting, non-timber forest products (NTFP) collection, and shifting cultivation for their livelihood. Shifting cultivation and hunting were banned in 1972 under the Wildlife Protection Act, following which the Soligas have sedentarized in settlements called 'podu' and continued settled agriculture (Murali *et al.* 1998). They received titles to their cultivable land ranging in size from 0.5 to 2 hectares from Forest Rights Act, which were notified as revenue villages in 1913 (Karnataka forest department, 2000). Today, there are 31 Soliga settlements either within or near MM Hills forest with 1030 households and a population of 7,100 (Census 2011). Bedagampana is another indigenous community in MM Hills forest, they are known for hunters from their ancestors (Harisha *et al.* 2015; Shaanker *et al.* 2004). They settled in MM Hills about 600 years ago as followers of goddess Mahadeshwara and stopped hunting. Many of the households work as priests in the temple. Though they were brought to MM Hills as priests, they depended on agriculture for their livelihood. This community largely inhabited the Chamarajnagara and Mysore districts of Karnataka state and the adjacent districts of Dharmapuri and Erode in Tamil Nadu state. The Bedagampana families are spread in 33 villages in and around MM Hills. Their culture and lifestyle are very similar to the Soligas except they are vegetarians.

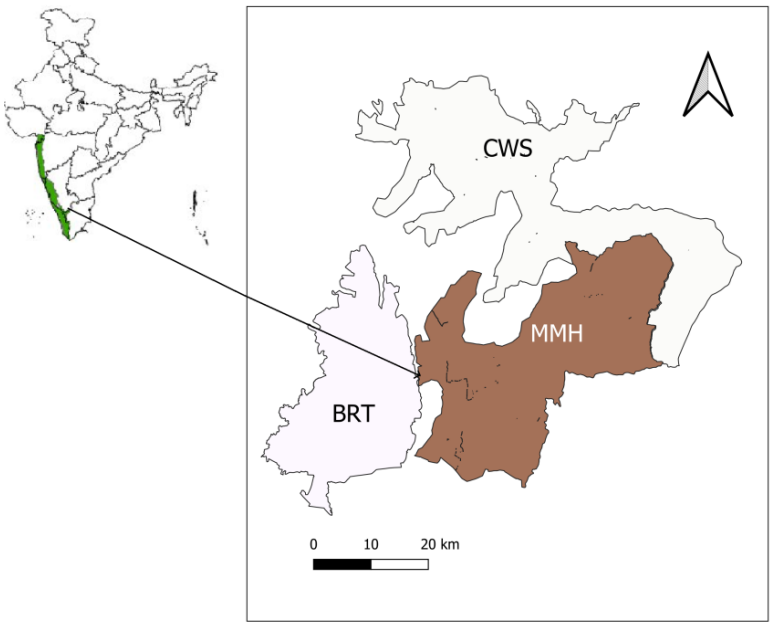

Figure 1. Location of study site, Western Ghats, Karnataka, India (BRT-Biligiri Rangaswamy Temple Tiger Reserve; CWS-Cauvery Wildlife Sanctuary).

Historically, both the communities earned their livelihood through agriculture, the sale of non-timber forest produce (NTFPs), basket weaving, or through wages working as migratory laborers at stone quarrying, coffee estates, and cities (Harisha *et al*. 2013; Shaanker *et al*. 2004). They practice rain-fed farming in which they grow Finger millet (*Eleusine coracana*) and Hyacinth bean (*Dolichos lablab*) as subsistence crops, and Jowar (*Sorghum vulgare*), Maize (*Zea mays*), and Sunflower (*Helianthus annus)* as cash crops. Their farming system is quite traditional and lacks technological adaptation; 78% of farmers practice organic farming (Jadegowda and Ramesh 2008). Agricultural activities are very seasonal (June to December) and as such the yield falls short of even the basic subsistence needs. The agricultural produce is only sufficient for less than 6 months in a year. The WFPs and the Public distribution system (food scheme of the state government) fill the food shortage (Harisha *et al*. 2015). They have primarily been dependent on the forest for rearing cattle, NTFPs collection for their cash income.

Ethnobotanical methods

Eight villages were selected for the study based on the community composition, distance from the town, and location in the forest. Two villages were located at the periphery of the forest, and the other six villages were located within the forest. Among eight villages, five villages were located close to town and the main road. The remaining three villages were located deep inside the forest, and they do not have road connectivity. Four villages which have both Soliga and Bedagampana communities, another four villages with only the Soliga community were selected for the study. Soliga has been living in these villages for centuries and the Bedagampana community for around 600 years. Though, both the communities have been collecting and using WFPs every day. However, the Soliga community consumes plant-based food (vegetarian) on a regular diet and occasionally consumes animal-based food (non-vegetarian). But Bedagampana consumes only plant-based food (vegetarian) and strictly practice a vegetarian diet throughout their life. The relevant qualitative and quantitative data was collected from January 2018 to March 2019 through free listing exercises, household surveys, focused group discussions, and key informant interviews. Prior informed consent (PIC) was taken from the participants for the study with the intent of ensuring welfare, equitable sharing of benefits (monetary and non-monetary), and protection of traditional knowledge. After obtaining the consent of the knowledge holders that the knowledge will be placed in the public domain through publication, the data on this study was processed for publication.

Free listing and community walk

The free listing technique was used to capture data on plant identity, harvesting, the mode of consumption, and availability patterns (Lykke 2000). This technique allows the respondents to list WFPs species that comes to his/her mind until they are exhausted. The community walk was also conducted in the summer, rainy, and winter seasons

to capture all the WFPs used in different seasons. The community walk was undertaken for about 8 kilometers distance covering major land-use types (farmland, fallow land, forest land, water bodies, and roadside) which were decided by the community. The community walk was undertaken in Gorasane village, which is close to the main temple located in the middle of the forest and represents both the communities. Similarly, the 'community walk' was also undertaken in Palar village. This village is located in the fringe of the forest and has only a Soliga community. People from both communities have participated in the walk. On average, 15 people aged between 30 to 55 years with four women and the rest of the men.

During the community walk, plants were identified and documented in local names with the help of the participants, and samples were collected for further reference and as a herbarium depository. Also, ethnographic information was recorded from the participants on the collection methods, processing, and recipe preparation, and therapeutic values. At the end of the walk, the plant materials collected were authenticated by knowledgeable elderly people. The preliminary identification and documentation (using scientific and vernacular names) were done by examining fresh plants procured by the villager with the help of local flora (Gamble 1957; Saldhana & Nicholson, 1976). The voucher specimens were deposited in the herbarium at the Community-based Conservation Centre (CCC) at MM Hills managed by ATREE with the collaboration of local communities and their institutions.

Household survey

Semi-structured interviews (Newing *et al.* 2011) were conducted for 184 households from eight villages. The interviews were conducted for 23 households, which was 10% of the total households of the village. The households were selected for the interview by considering the family size (number of people in the house) and occupation (farming, daily wage, and others) to draw reliable information. Women were part of the farming activities and play a significant role in decision-making when it comes to agricultural activities in both communities.

The household survey was conducted in 2018 and the same households were revisited in 2019 to fill the gaps, cross-check, and validate the information on WFP's use and socioeconomic profile. During the interviews, vernacular names and photographs of the wild plants were used along with the questionnaire to avoid confusion. The interviews were focused on the WFPs known, frequency of use, reasons for use, and sharing patterns and dietary values. A list of WFPs known, collected, used, and shared from the farms and forests was prepared separately. The respondents' households were also asked about the crops under cultivation, WFPs collection methods, dietary practices, therapeutic value, multiple-use, reasons for sharing, and preparation methods (recipe). The household interviews were of 1-3 hours duration, and the households were revisited for reliability. A clear expression of consent was obtained before each interview. Throughout this field study, ethical guidelines as stated by the International Society of Ethnobiology (ISE 2008) were adopted.

Focus group discussion

Focus Group Discussions (FGD) were conducted twice a year for 2018-19 in all eight villages. The questions were based on the household interviews and previous studies to capture and fill in the missing information, and to validate the information during the household interviews. FGDs were helpful to share their experiences and knowledge on WFPs. Sixteen FGDs was conducted in the eight study villages, of which two FGDs were conducted in each village at six-month intervals. The average number of participants in each FGD was ranged from 16 to 28 people. In each of the FGD, more than 30% of total participants were women and 40% of them were above 60 years old. Equal numbers of participants were present from both the communities in all the FGDs. All the participants actively participated and shared their knowledge.

Discussions were held with knowledgeable men and women aged between 18 to 80 years in all eight villages. During the meetings, shortlisted questions were asked; WFPs photographs were showed to the respondents to assess their perception of the livelihood implications of WFPs. The responses were recorded in detail regarding the dietary values, medicinal values, TEK of the WFPs, multiple uses and benefits of sharing food plants. These meetings usually lasted 3-5 hours.

Key informant interviews

Eight key informants (one person from each village) were identified based on their popularity in the village on the subject and interviewed to cross-check the information collected during the household survey and focus group discussions. The key informants were known to be the most knowledgeable elderly men and women, who had lived and worked in this area and had been using WFPs for a long time. They were frequently consulted during the study

to clarify any doubts or confusion regarding the parts used nutritional importance, food, and therapeutic values, and TEK, and the benefits of sharing to the households.

Data analysis

The data collected during the community walk and household surveys were conducted to assess the number of species collected, source, the season of collection, parts collected, and frequency of use. Descriptive analysis was used to categorize the WFPs in terms of the plant family, genus, and plant part used life form and use category. The percentage of species used in the forest and farmlands were calculated. Further, the relative importance across life forms and the percentage of different parts used for food were calculated.

The relative frequency of citation (RFC) was determined for each species as the ratio of respondents who mentioned a particular species to the total number of respondents in the study area. Also, RFC was computed for each use category, lifeform, and season. The RFC values range from 0 to 1 and are a measure of relative importance. Furthermore, the informants' consensus factor (FIC) was computed for each used category to determine the homogeneity of information given by respondents using a formula FIC = Nur - Nt/(Nur –1), where Nur is the number of user reports from informants for a particular plant use category and Nt is the number of taxa or species that are used for that plant use category of WFPs species (formula was adapted from Samuel *et al*. 2019 with relevant changes).

Key informant's interview data were used to validate the quantitative and qualitative information collected from the household survey and FGD. The household data was also used to develop a socio-economic profile and create a map of the WFPs sharing network. Based on the information obtained from the interviews and with the help of local people WFPs sharing web maps were developed on a google sheet. A Chi-square test was performed to examine the preferences for WFPs over other non-WFPs across different seasons. The household survey, FGD information, and key informant interview data were used to calculate the Chi-square test.

The multi-functionality of WFPs was weighed and ranking was given for each species based on different uses. Similarly, the study computed the community responses obtained from FGD, key informants, and household interviews on harvesting practices conservation issues of WFPs. The community's responses on the traditional practices in harvesting and multiple WFP species were also computed. The quantitative and qualitative data analysis was carried out using a spreadsheet and R (version 3.3.1) (R Core Development Team 2013).

Results

Socio-economic profile

According to population census 2011, both communities having medium-size families (4 to 6 people per household) account for ninety percent, and large size families (8 to 12 people per household) were only ten percent. The literacy position of the respondents revealed that about 80 percent had no formal education while only 20 percent of the respondents had formal education. Amongst 20 percent of these educated families, their education was limited to primary school (up to 7th grade). Both communities had very similar gender and occupation patterns. Women lead the family spending 60% of their time and 25% for their agricultural work, 15% for out-migration for a few months. Men work outside as migratory labourers in stone quarries (situated 300 km away) and coffee estate (250 km) apart from agriculture work, non-timber forest product collection, and local daily wage work. However, their diet is quite different from each other. The soliga have been practicing both vegetarian and non-vegetarian food diets, whereas, Bedagampana has only a vegetarian diet (Table 1). Though both the communities have greater similarities in socio-economic and cultural activities, their food habit systems are quite different.

Wild food plants as a source of food

WFPs resource and dietary diversity: The study has documented 126 WFPs species, belonging to 94 genera and 58 families in MM Hills (Appendix 1). The study communities reported the average number of WFPs collected from the farmland (50 species), forest (64 species), and other land use (12 species) (Figure 2). Collection usually comprised of wild leaves 52 species (41.2%), shoots 5 species (3.9%), tubers 8 species (6.3%), flowers 4 species (3.1%) and whole plant 3 species (2.3%) for their common nutritional diet, medicine, as a feed, as agriculture tool, for cultural activity and offers during festivals. The six plant species which have the highest RFC scoring are *Jasminum ritchiei*, *Cocculus villosus*, *Canthium parviflorum*, *Holostemma annulare*, *Celosia argentea*, and *Solanum nigrum*. The families Solanaceae, Amaranthaceae, and Anacardiaceae had five edible species each. Both the communities consume a high proportion of wild leaves as greens fall in the category of weeds (83%) from forests, farms, wasteland, and kitchen gardens. Though this weed is a human perceived ecological concept, 88% of

respondents reported that these plants have potential features like high reproductive capacity, rapid growth, and a high range of adaptation to different environmental conditions. The highest number of WFPs species was recorded in Gorasane village (98 species) while the lowest was in Palar village (52 species). There were 23 WFPs species common across the villages with *Jasminum ritchiei*, *Alternanthera sessalis*, *Celosia argentea*, *Solanum nigrum*, *Dendrocalamus strictus*, being abundant in all the villages.

Table 1. Socio-economic profile of the communities

Factors	Soliga	Bedagampana
Family size	4.42 ±2.04	4.60±2.03
Landholding	1.48±1.19	1.67±1.25
Clan system	One group with 5 clans	One group with 5 clans
Number of villages (Podu) spread	143 villages in 5 districts	128 villages in 2 districts
Present diet system	Vegetarian and non-vegetarian	Vegetarian
State reservation category	Scheduled Tribes (ST)	Other Backward Classes (OBC)
Free Food schemes from State Govt.	PDS + special nutritional package (100% free) for every household.	PDS only for Below Poverty Line (BPL) households.
Traditional occupation	Hunter-gatherers and shifting cultivators now settled agriculture and no hunting.	Hunter-gatherers turned priest and settled agriculture from beginning.
Average income/capita/year	₹ 26041.00	₹ 26527.00
Source of income	Migration (59%), Farming (31%), Local labour (3%), NTFPs collection (7%)	Migration (48%), Farming (38%), Local labour (5%), NTFPs collection (9%)
Economic status	>80% of households are below the poverty line	<50% of households are below the poverty line
Number of WFPs known	112	108

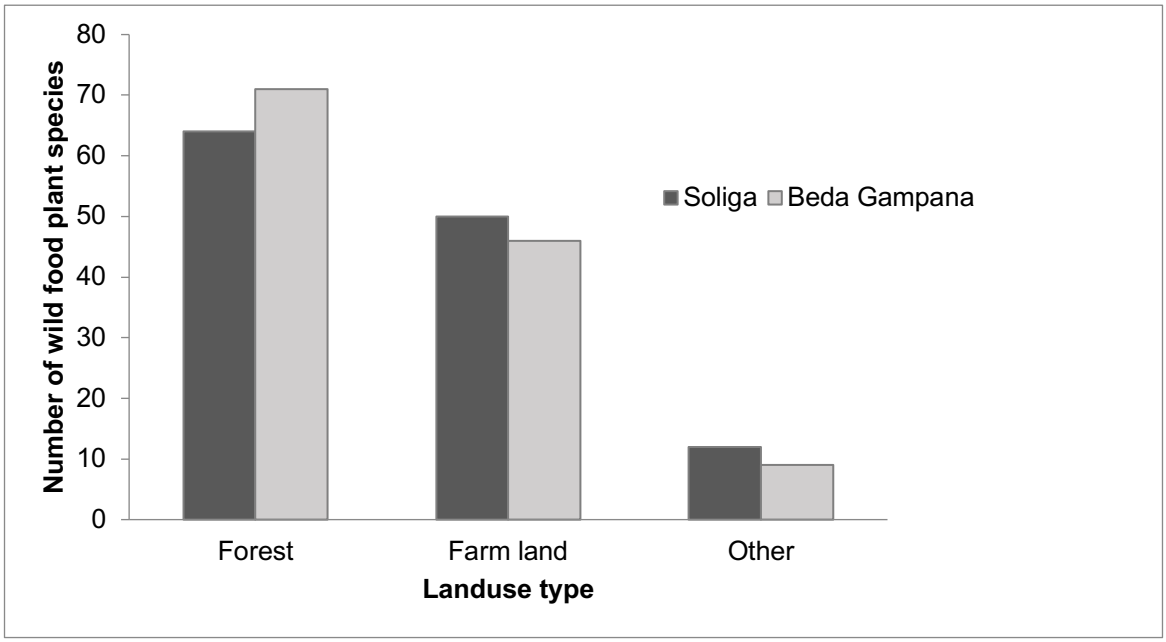

Figure 2. Number of WFPs species reported from forest and farmland.

Use categories of WFPs species: The WFPs species belong to five lifeforms namely, herbs, shrubs, trees, climbers, and grass. Of all the identified species, 48% were trees whereas, only 1.5% were grasses. We noted that the herbs (FRC=0.48) and trees (FRC=0.34) are the most important source of WFPs, while the grass is the least important (RFC = 0.01) (Figure 3). About 42.8 % of WFPs as herbs of which are seasonal leafy vegetables regarded as diet and medicine. Around 26.9% as trees of which are seasonal fruit-bearing trees are regarded as tasty and healthy by the

tribal communities and a few are marketable. Also 17.4% as shrubs of which are seasonal fruits, followed by 11.1% as climbers of which are seasonal tuber, greens, and fruits. The popular fruits are eaten raw and many herbs/shrubs and leafy shoots are eaten as cooked food.

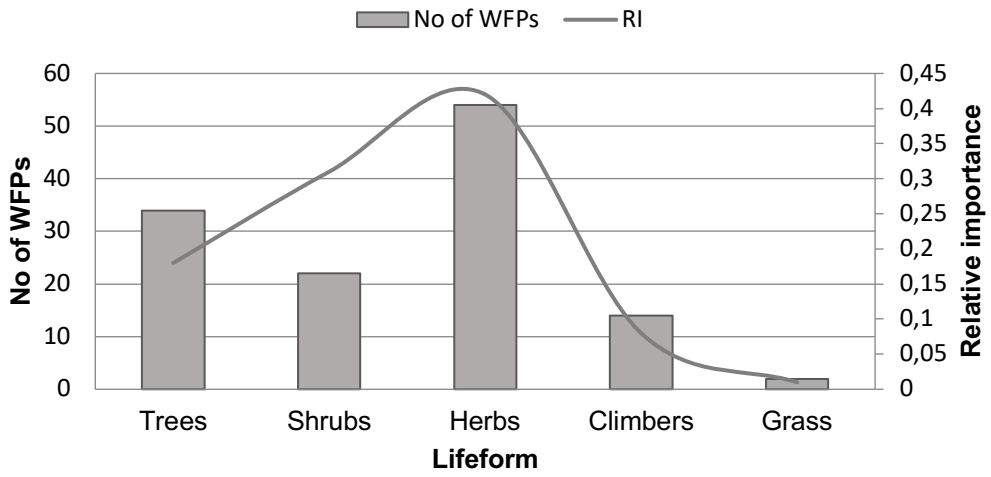

Figure 3. The relative importance of the lifeforms of WFPs species.

The five use categories of WFPs have been documented in MM Hills such as fruits, vegetables, seeds, tubers, and gum. The informant consensus factor (FIC) analysis of WFPs revealed that 61 vegetables species had 595 use reports (FIC=0.94), 44 fruiting species have 124 use reports (FIC=0.89), eight species of seed use category had 19 use reports (FIC=0.82), 11 tuber species had 46 use report (FIC=0.96) and 2 gum yielding species had five use report (FIC=0.78). The informant consensus factor determined the homogeneity of information given by respondents.

The leafy vegetables comprised 49% out of 126 species fruits 35%, tuber 12%, and seeds and gum comprised 2% each. Most species provide food that is eaten raw (36%) while the remaining species (64%) require cooking. The WFPs species such as *Scutia myrtina*, *Syzygium jambos*, *Syzygium cumini*, *Carissa carandas*, *Ziziphus oenoplia*, *Ziziphus jujuba* are commonly and more frequently consumed raw fruits (Appendix 1). Respondents agreed that fruits (RFC=0.41) have an important use value followed by leafy shoots (RFC = 0.56). The relative importance of fruits, vegetables, and gum corresponds with the prominence of species consumed in each category except for tubers which are relatively more important than seeds (Figure 4).

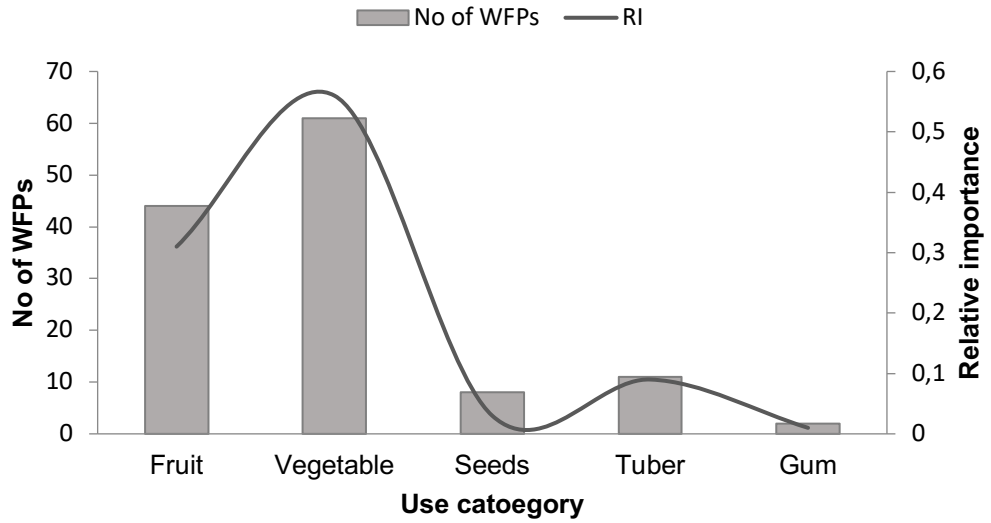

Figure 4. Use categories of wild food plant species and relative importance.

Analysis of the frequency of use shows that 28 species of leafy vegetables are used by at least 80% of households for more than 20 days in a year. About 26 species, including leafy vegetables, are used by 60 - 80% of households for more than 10 days in a year. Around 24 species, comprising of leaves, fruits, and shoots are used by 40 - 60% of the households more than 5 days in a year (Table 2). Similarly, more than 90% of the households have their recipe for preparing WFPs for dinner. Interestingly, Soliga households (85%) use WFPs more than 5 times a week, whereas the Bedagampanas households (68%) use WFPs 2 to 3 times a week.

Table 2. Number of species and use frequency at the household level.

Frequency of use days/year	No. of species	% of households use	Major species
>20	28	80 to 100	*Jasminum ritchiei, Solanum nigricum, Celosia argentea,* etc.
10 to 19	26	60 to 80	*Cordia wallichii, Cocculus hirsutus, Digera arvensis, Amaranthus viridis,* etc.
5 to 9	24	40 to 60	*Amaranthus polygonoides, Alternanthera sissilis, Bacopa monnieri, Boerhavia diffusa,* etc.
2 to 4	28	20 to 40	*Holostemma annular, Coccinium grandis, Acacia farnesiana, Solanum torvum, Agaricus bisporus, Euphorbia heyneana,* etc.
One	21	0 to 20	*Dioscorea bulbifera, Grewia hirsute, Anredera vesicaria,* etc.

Seasonality of WFPs and consumption patterns: The seasonal availability of WFPs varies across months and seasons. They are most abundant from May to January in the rainy and winter season and less abundant from February to April during summer. The number of species recorded in each season, in rainy season 67 species, winter 56 and summer 32 species. More than 12 species are used by the community throughout the year. The percentages of the WFPs diet in the study community varied across the season. For Soliga's diet, WFPs comprised 36% in summer, 64% in rainy, 41% in winter. Similarly, Bedagampana's diet was contributed by WFPs: 31% in summer, 58% in rainy, 39% in winter. Similarly, by using the chi-square test significance of WFPs contribution compared to non-WFPs species (includes cultivated vegetables or purchased from local market) across the seasons was estimated. Across the season WFPs have a significantly greater contribution to the diet of both the communities (Table 3).

Table 3. Seasonal WFPs use and the pattern.

Season	No. of WFPs	No. of Non-WFPs	Total species	% of WFPs	Chi-square value	P-value
Rainy	67	18	85	78.82	701	0.001
Winter	56	16	72	77.78	654	0.001
Summer	32	20	52	61.54	1415	0.01
Total	155	54	209	74.16	2567	0.0001

The highest number of leafy vegetables and fruits were collected during the rainy season. Most tubers were available in summer (February to April) and shoots and flowers were collected in the winter (November to January) (Figure 5). Similarly, herbs collected for vegetables were available largely (42.3%) in June and July (rainy season). Climbers collected for tubers were available highest (36%) in February and March (summer). Shrubs collected for fruits and leafy vegetables were available highest in March. However, trees collected mainly for fruits ranged from 20.3% to 32% were available throughout the year.

Sociocultural and economics of sharing food: More than 80% of respondents perceived that in the Indigenous food system, sharing WFPs is very much part of their tradition. Community (90%) also perceives that sharing WFPs to relatives or friends and far relatives is respect and strengthens the relationship and it is a symbol of unity and prosperity among families. More than eight species of WFPs have been regularly shared a particular season of availability and special occasions within the community (Table 4). Both the communities have the tradition of sharing WFPs which are rare or not available in their relative's places (Figure 6). Ninety percentage of the respondents from both communities reported that sharing greatly contributing to maintaining their immediate relatives, socio-cultural relationships. Seventy-three percent of people also reported that sharing greatly helped those who are economically backward in the community (Figure 7).

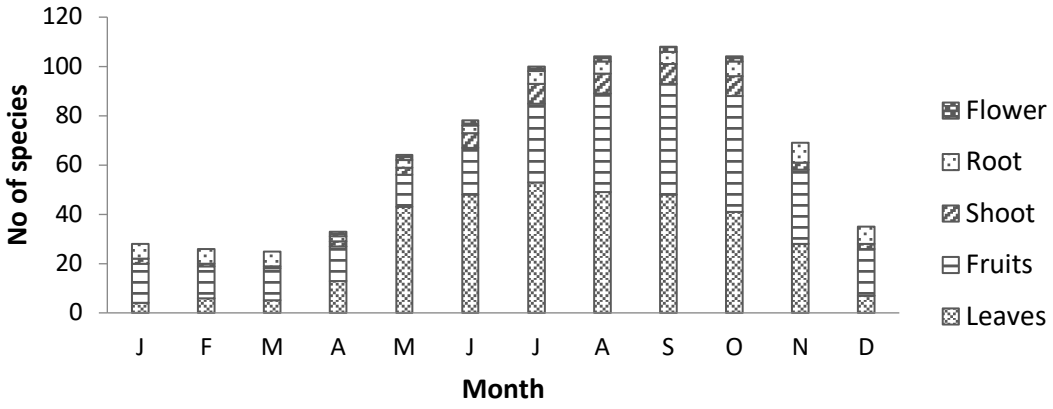

Figure 5. Seasonal forage calendar of WFPs.

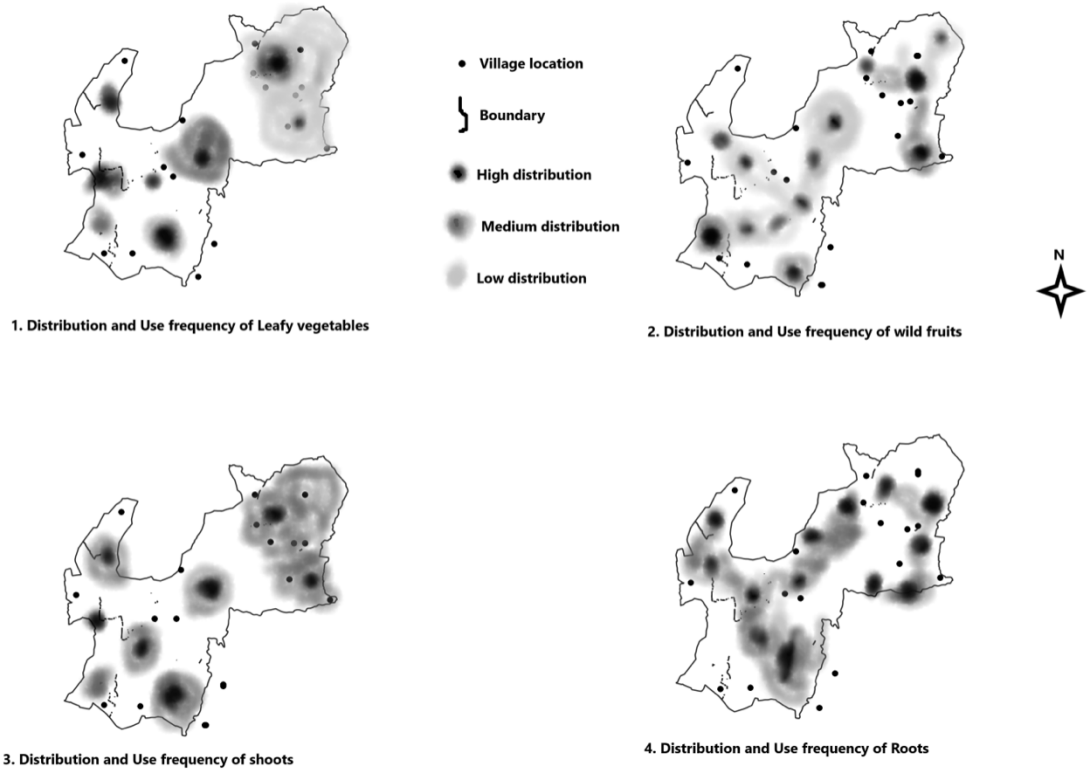

Figure 6. Distribution and frequency of WFPs use.

WFPs as a source of medicine

WFPs as therapeutic use in the indigenous food system: The majority of the WFPs species used in food by communities have some specific therapeutic values. The uses of over 126 species of WFPs as vegetables were classified according to the traditional concept of the hot-cold system. Community perceived that leafy vegetables sourced from farmland and water bodies are brought down body temperature whereas fruits and tubers which are usually collected from the forest would increase the body temperature. Some of the fruits and leafy vegetables do not have any impact on body temperature. Generally, in a family, women prepare food, decide diet practices and take care of health. She has gained knowledge on WFPs collection, processing, and preparation of recipes on day-to-day basis and also learned from elders. Here too, women from both communities emphasized the need to balance the overall food intake accordingly for optimal health. Such information has been recorded during the interviews. More importantly, 35 WFPs species, which have therapeutic values as cited by the respondents, are listed in (Appendix 2).

The local communities also use more herbs and roots of WFPs species as medicine while facing health problems and have adapted the indigenous system of preparation for common ailments like fever, cold, cough, headache, stomachache, ulcer, and skin allergies. About 120 herbs and roots species that are used as medicine are available only in the rainy and winter season. For example, *Boerhavia diffusa*, *Acacia farnesiana*, *Alternanthera sissalis*, etc. frequently used as vegetables, were reported to reduce blood pressure, increase iron in the blood, and improve eyesight. The most commonly used species were *Jasminum ritchiei*, *Celosia argentea*, *Cleome gynandra*, and *Cocculus hirsutus*.

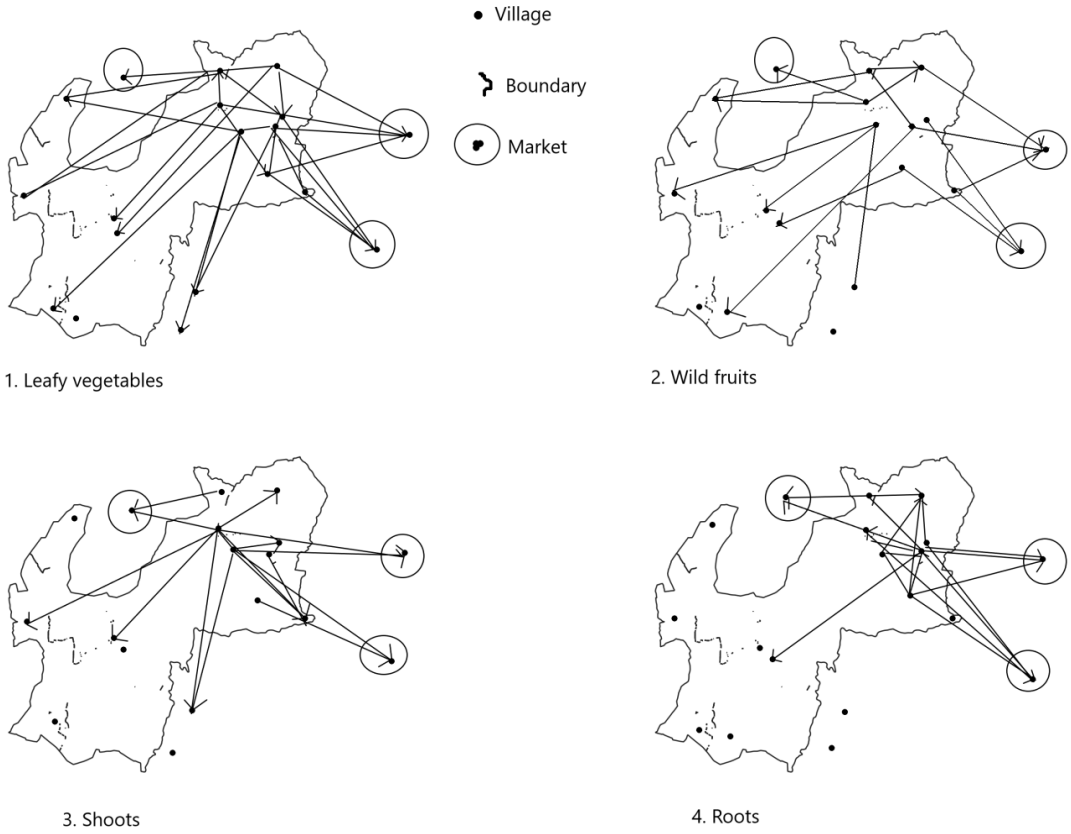

Figure 7. WFP sharing pattern within and between relatives and villages.

Table 4. WFPs sharing patterns between households and villages

Village	**Community**	**No. of WFPs species use by HH**	**No. of WFPs shared**	**Relationship and average number of time shared in a year**	**Frequently shared species**
Anehola	Soliga	46	7	Extended family (13), friends (2), colleagues (2), far relatives (3)	*Decalepis hamiltonii, Dendrocalamus strictus, Solanum nigricum, Dioscorea pentaphylla*
	Bedagampana	51	7	Extended family (8), friends (1), far relatives (4)	*Decalepis hamiltonii, Dendrocalamus strictus, Solanum nigricum, Dioscorea pentaphylla*
Asthur	Soliga	32	5	Extended family (6), friends (3), far relatives (5)	*Decalepis hamiltonii, Dendrocalamus strictus, Dioscorea pentaphylla*
Konankere	Soliga	52	9	Extended family (11), friends (1), colleagues (5), far relatives (10)	*Decalepis hamiltonii, Dendrocalamus strictus, Dioscorea pentaphylla, Cissus quadrangularis*

Medugnahane	Soliga	43	8	Extended family (9), far relatives (6)	*Dioscorea pentaphylla, Cissus quadrangularis, Holostemma annulare, Jasminum ritchiei, Solanum nigricum, Alternanthera sessilis*
Palar	Soliga	38	5	Extended family (7), far relatives (2)	*Cissus quadrangularis, Holostemma annulare, and Solanum erianthum*
Gorasane	Soliga	36	4	Extended family (8), colleagues (5), far relatives (3)	*Dioscorea pentaphylla, Jasminum ritchiei, Solanum nigricum, Alternanthera sessilis*
	Bedagampana	42	7	Extended family (6), colleagues (2), far relatives (3)	*Dioscorea pentaphylla, Jasminum ritchiei, Solanum nigricum, Alternanthera sessilis*
Keeranhola	Soliga	47	5	Extended family (5), Friends (3), far relatives (4)	*Decalepis hamiltonii, Dendrocalamus strictus, Dioscorea pentaphylla, Jasminum ritchiei, Solanum nigricum, Alternanthera sessilis*
	Bedagampana	38	3	Extended family (7), friends (5), colleagues (6), far relatives (8)	*Dioscorea pentaphylla, Jasminum ritchiei, Solanum nigricum, Alternanthera sessilis*
Kombadukki	Soliga	45	7	Extended family (12), far relatives (2)	*Syzygium jambos, Mangifera indica, Dimocarpus longan, Centella asiatica, Bambusa bambos and Colocasia esculenta*
	Bedagampana	34	4	Extended family (10), friends (1), colleagues (4), far relatives (2)	*Syzygium jambos, Mangifera indica, Dimocarpus longan, Centella asiatica, Bambusa bambos and Colocasia esculenta*

Many respondents reported that methods of change in recipe preparation, ingredients, frequency of use and varied at season and type of disease they treat. For instance, recipe (smash/**massappu**) preparation using **annesoppu** (*Celosia argentea*) in summer helps to prevent or reduce body temperature. Preparation of recipe (soup/**bassaru**) by using the same **annesoppu** in the rainy season used to enhance body temperature. They use garlic, pepper, and dry chilly as ingredients in the preparation of soup/**bassaru** whereas, green gram is used to prepare smash/**massappu** during summer. Women also use *Solanum nigrum* more frequently in different forms leaves soup to cure throat pain, and salad (pan-fried snack) to cure fever. Similarly, they use leaves of *Jasminum ritchiei* as a salad (pan-fried snack) to cure dysentery/Acidity (Appendix 2).

Multi-functionality and plasticity of WFPs

The FGD and key informant's interviews revealed that 104 species (82%) of WFPs had more than one function in the livelihood systems of local communities. About 69 species (74%) of WFPs identified in this survey were recognized for their specific therapeutic or curative properties. Also, 69 species (55%) were used as livestock feed, 16 species (13%) used for farming and household tools, 12 species (9%) had culture and sacred uses. For some species, the same parts were used for both dietary and medicinal purposes and only the concentration or preparation differed when used in special therapies. Similarly, 34 species (29%) of WFPs were used as medicine,

animal feed, and farming and household tools apart from food. More than 14 species (12%) of WFPs are used as cultural, sacred, medicine, animal feed, as well as farming and household tools apart from food (Figure 8).

It was also reported that members of the community preserved and stored some of the plants to guarantee supply during the off-peak seasons. More than 12 species are rare and important for medicinal food, which they have been growing in the backyard and farmland. The species mentioned include *Limonia acidissima, Coccinia grandis, Cissus quadrangularis, Colocasia esculenta, Asparagus gonocladus, Anredera vesicaria, Acacia concinna, Alternanthera sessalis, Amaranthus spinosus, Annona squamosal, Amaranthus caudatus, Cordia wallichii, Dendrocalamus strictus, Solanum arcanum Peralta, Solanum arcanum, Solanum erianthum, Solanum nigrum, Syzygium jambos.*

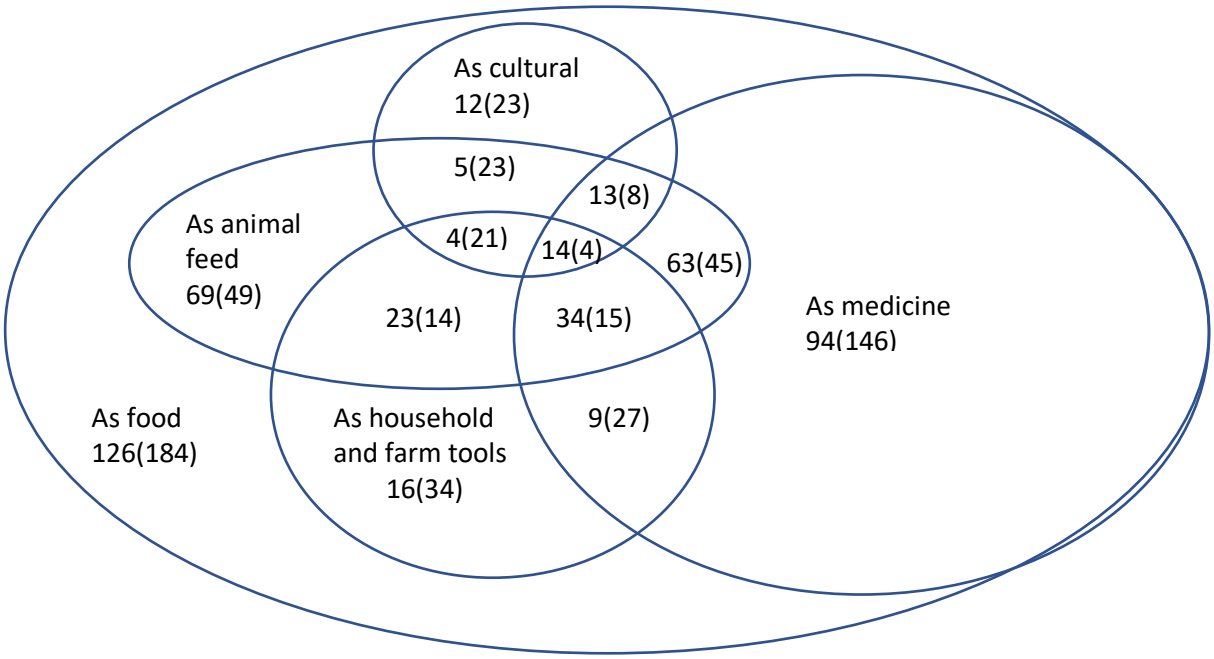

Figure 8. Multi-functionality of WFPs; Number of species showing the overlapping among them. In parentheses is the mean number of use reports for all the species of that category.

Discussion

Need a voice to Indigenous food practices

The WFPs have a greater contribution to the local biodiversity of any given geographical area which determines the dietary diversity and nutritional security of the forest-dwelling communities (Ogle *et al.* 2003; Mundaragi 2017). In the study area also WFPs diversity reflected in dietary diversity and contributing to the nutritional security of the indigenous communities for centuries. The key informants have perceived that the season and frequency of harvest varied from plant to plant, and it was depending on the availability of edible plants and their parts. It also varied from place to place due to ecological and climatic conditions. For instance, the leafy shoot of *Acacia farnesiana* and *Dioscorea pentaphylla* tuber had to be collected in a narrow period of only a month in summer. On the other hand, some leafy vegetables such as *Amaranthus viridis*, *Glossocardia bosvallea*, *Alternanthera sessilis*, and *Boerhavia diffusa* were available for a wider period of more than 4 months in a year during rainy and winter seasons. Few species were also available throughout the year, for example, *Celosia argentea, Canthium parviflorum, Senna tora, Cleome gynandra,* and *Digera muricata*. However, the indigenous knowledge on WFPs uses and dietary practices are still rudimentary and not recognized, shown outside world (Shackleton and Shackleton, 2006; Agea *et al.* 2011; Mundaragi 2017).

Seasonal availability of WFPs

The local communities well understood seasonal plant availability and their phenological status (Harisha *et al.* 2013). Plenty of shoots and wild leafy vegetables were available in the rainy season compared with the dry season, it is true in Asia and African developing countries (Sheckilton and Sheckilton 2004; Rathore 2009). Similarly, many wild fruits were available in the winter season for consumption. It is true that without WFPs, the local people in MM Hills would have starved or suffered from malnutrition (Harisha *et al.* 2013). This could be applicable in forest landscapes and indigenous communities in India and across developing countries.

The WFPs species such as *Dioscorea pentaphylla, Bacopa monnieri, Amaranthus tristis, Carissa carandas, Ziziphus mauritiana, Decalepis hamiltonii, Asparagus gonocladus, Acacia farnesiana* play an important role in enhancing the dietary diversity and essential nutrients for the community. During the rainy season, 57 species of leaves and shoots and 23 species of wild fruits are sources from forests and farmland. The relative seasonal importance of the WFPs species shows that they are more important in the rainy season to keep the body healthy and supply rare and essential nutrients (Kalita *et al.* 2014). This seasonal relative importance greatly determines households' food, nutritional security, and has the coping ability. The earlier study asserted that in times of food scarcity, WFPs make human diets more diverse and add flavour, vitamins, and minerals (Harisha *et al.* 2015). Globally, WFPs have been recognized as a key component in ecosystem-based adaptation and food scarcity coping strategy (Puri 2015; Sansanelli and Tassoni. 2014).

Consumption patterns

Though everyday meal patterns are similar, however, they use a variety of green leafy vegetables, fruits, tubers in their food (in preparation of gravy) or eaten raw (in case of fruits). Soliga occasionally consumes chicken, fish, or mutton in the form of gravy along with finger millet dumplings (12 to 20 times a year), especially during festivals. They rarely purchase vegetables and fruits from the market and are mainly dependent on the crops grown in farmland as well as WFPs gathered from forest, backyard, and farmland. For Soliga, meat is usually purchased from local chicken and mutton shops; fish was caught from rivers/streams/ponds or purchased from local fishermen. Bedagampana families do not consume meat, but Soligas consume them an average of once in two months. It was limited to certain occasions during local festivals and family functions and purchase from the local market. Both the communities' food habits were mainly dependent on crops grown in farmland and WFPs. These two communities have been celebrating many festivals and their folktales and songs have a unique position in their culture (Madegowda, 2009). For instance, they prepare **annesoppu** (*Celosia argentea*) and **nuregenasu** (*Dioscorea pentaphylla*) recipes and offer God during local festivals called **sankranthi** (Harvest festival) and **shivarathri** festival.

Finger millet has been a staple food in the diet of the communities as they grow it as the main crop. Rice is also becoming part of the diet of many families because they are getting nearly 25-30kg of rice per month at the subsidized price/free of cost under the public distribution system (PDS). Field bean, horse gram, red gram, and cowpea are also figured in their regular diet. They use pulses along with WFPs mainly in the preparation of gravy and consume with rice or finger millet dumplings. The quantity of consumption of these pulses is further dependent on the availability and season. They occasionally use milk and milk products. Apart from gathering WFPs from the forest, some of them maintain a kitchen garden in front or backyard of the house depending on the space availability. They cultivate some fruits such as banana, jack, guava, and vegetables such as pumpkin and guards. Their WFP gave value to their diet as it enhances micronutrient supplements and increases the diversity of their diet sources. Apart from food and nutritional security WFPs harbour great cultural significance to rural populations in developing countries and their attachment to culture partly explains why the ancient hunter-gatherer tradition still persists in some Asia and African communities (Age *et al.* 2012; Shrawan *et al.* 2013; Muller and Almedom 2008).

Socio-cultural linkage; sharing and caring

Both the communities have a habit of sharing the available WFPs that are with their neighbours and relatives. Usually, people share WFPs as a token of gift, an emblem of love, thus indicating their caring nature. This happens with high-value products and when other villagers lack that resource. Sometimes sharing particular WFPs is a cultural practice that is regularly being followed through generations (Madegowda 2014). Similarly, in MM Hills both communities also share WFPs (like greens, fruits, and tubers) with people in the plain. Villages located 20-25 km from the forest villages like Govindapadi, Hodkeholla, Kolthur receive WFPs, and in return, they gift household items (utensils, pottery, garments, stationery, etc.). Food sharing practices are the sequence of distribution events that start as soon as they get the resource. Food sharing must be interpreted as a more complex cultural phenomenon, whose variation over time and space cannot be ascribed only to local adaptation (Muller and Almedom 2008). The importance of sharing food has been highlighted in studies that are related to the evolution of cooperation and sociality, the social division of labour, and from hunting and gathering to settled agriculture. In evolutionary biology and ecological view, sharing was described as fitness on their actual or perceived benefits to group physical and social survival (Agea *et al.* 2012; Muller and Almedom 2008).

WFPs as a source of medicinal food

The medicinal value of some foods is not just for healing diseases but also for providing health-enhancing substances other than calories and proteins, such as vitamins and minerals. These micronutrient supplements are critical in a diet based on staple agricultural and livestock products. *Jasminum ritchiei, Alternanthera sessilis, Solanum nigrum, Celosia argentea*, and many others are the most commonly harvested wild vegetables in MM Hills which are very wholesome and nutritious plants rich in vitamins and minerals especially iron, found in its leaves (Harisha *et al.* 2015). The local herbal healing practices or "**naruberuoushadi**" (roots and tubers for medicine) is the indigenous healthcare system very well exists till now (Sudarshan *et al.* 1993; Madegowda 2009). Records have shown that local communities have been using about 300 wild plants for the treatments of various ailments of the body, mind, and soul (Sudarshan 1998). The direct nutritional benefit of adding even small daily quantities of trace minerals and vitamins to the intake of sick or malnourished individuals may be sufficient to alter the metabolic uptake or restore the balance between nutrients and thereby improve body functioning (Rathod and Valvi 2011). It is very much evident from studies across the world that WFPs has disease-preventing or health-promoting roles which supply several bio-active substances (Jose *et al.* 2017).

Over the last 150 years or so, biomedicine has increasingly focused attention on the specificity of both disease and treatment and by doing so, has positioned food outside the domain of therapeutics. Science has regarded food as a chemically routine, of no relevance to the disease process (Etkin 2002). But this was not the case either during the history of biomedicine or in indigenous communities' food culture (Rathod and Valvi 2011). Food and health have always been interrelated, as is shown in the Ayurveda system of medicine in India. Since seventeenth-century literature claims, 'the health of the whole body is forged in the workshop of the stomach (Jain 1991).

Multi-functionality and source of resilient food

In recent decades, the idea of the multi-functionality of foods and their influence on health has been renewed among the scientific and medical elites. In our compilation of wild vegetables traditionally used in India, at least a few hundred species recorded are also said to be multiple uses. The young stems and leaves of *Jasminum ritchiei* are considered useful as an anti-diuretic, either in decoctions or even eaten boiled as a vegetable, with the latter preparation being reported to cure stomachache (Harisha *et al.* 2015). In India, Britishers have recorded medicinal uses of hundreds of WFPs and published in the Fort St. George Gazette, 1910. There are many other examples of plants used for multipurpose, such as *Syzygium jambos, Solanum nigrium, Toddalia asiatica, Oxalis corniculata*, etc. are reported to have digestive or intestinal anti-inflammatory properties. The *Commelina benghalensis, Cocculus villosus, Portulaca quadrifida*, and many other species of wild vegetables have lost their importance as a medicine among the present generation who considered them merely as foods, unlike in ancient times. In those cases, the current food use could be a reminder of their ancient medicinal use (Shumsky *et al.* 2014).

The mode of consumption is another important subject to know how the different species were/are traditionally consumed. They could be eaten raw, sometimes directly in the field as a snack, or used for preparing salads. Respondent reported that the number of use categories, in many cases the number of WFPs species consumed in each category, showing the overlapping among them. Mixed green recipe preparation and consumption is another important indigenous dietary practice of the local communities. Women prepare a recipe with a blend of nine to thirteen species of WFPs known as **bereke-soppusambaru** (mixed green curry) which is very common in the rainy season and are compulsorily eaten at least once a year. Women believe that having mixed green gravy is an immune booster and cures many common ailments.

Many studies also revealed that local knowledge of food and medicine is so interconnected, and evidence for the origin of uses, knowledge acquisition, and transformation were well explained (Ladio and Lozada 2003; Shumsky *et al.* 2014). Nevertheless, how foods became medicines or vice-versa is surely less important than the fact of their multi-functionality. The WFPs species are used for five reasons, namely hunger due to food scarcity, spicing staple food, preservation of cultural practice, nutri-medicinal value, and their delicacy. *Decalepis hamiltonii, Solanum nigrium, and Jasminum ritchiei* were commonly mentioned nutri-medicinal plants for treating various ailments. It is evident that the indigenous system of food and therapeutic practices has a potential role for future food and acts as a safety net for the resilience of the local community (Sansanelli and Tassoni 2014).

Indigenous practices and conservation

The TEK system has inbuilt practices of sustainable use and conservation of the resource which is well understood from indigenous food harvesting practices. Even today communities harvest WFPs using three rudimentary methods, namely digging (tubers and roots), plucking, and collecting from plants (fruits, seeds, and gum), and ground collection of fallen seeds and fruits. The prominence of these techniques was in the order of plucking from

mother plants (82%), collecting from the ground (13%), and digging (5%). Some of these WFPs species are weeds and they are available in the farmland and wastelands therefore, currently sustainable use won't be relevant (Bharucha and Pretty, 2010). However, the respondents during FGDs also reported different conservation concerns such as Pesticide use in farmland, erosion of knowledge, and over-harvesting of tubers/root/whole plant and species which has a potential impact on their survival needs in-depth study.

In the current rapid economic development, little attention is paid to indigenous knowledge and the use of the many naturally occurring vegetable species in the farming systems (Bharucha and Pretty 2010). This may pose a threat to the reservoir of diversity that WFPs constitute, to farmers' conservation of traditional foods through use, and to a comprehensive understanding of the role of wild plants have in the health and nutrition of rural populations. Moreover, the respondent reported that the WFPs were mainly harvested using three rudimentary methods, namely digging (tubers and roots), plucking, and collecting from plants (fruits, seeds, and gum), and collection of fallen fruits and seeds on the ground. The prominence of these techniques was in the order of plucking from mother plants (82%), collecting from the ground (13%), and digging (5%). It is well noted that, in contrast to the strong support for the protection and cultivation of medicinal plants, natural food plants are neglected in-state resource assessment and policymakers (Muller and Almedom 2008). The direct nutritional significance of WFPs used either as a vegetable or in different therapies or for both continues to be crucial to many rural populations (Manju *et al.* 2004; Gordon and Enfors 2008).

Conclusions

It is essential to raise the voice for protecting and promoting local WFPs and their use knowledge, highlighting their role in the food basket, and to achieve self-reliance on nutritional food through the promotion of value addition and marketing. Globalization, developmental activities, and food production with high environmental costs have been pushed us to find a better alternative to ensure food security. The world is moving towards new food strategies combined with health and nutrition locally to address long sustained interrelated food security and malnutrition. Incidences of diet-related diseases are on the rise, especially high in low- and middle-income countries. The foods of animal origin are often not affordable to them, which would be compensated by only alternative indigenous food practices.

Complex and dynamic biocultural food systems that allow for better elucidation of the connection between biodiversity and nutrition would need interdisciplinary and systems thinking. This study has summarized and discussed our current knowledge of the traditional uses of wild vegetables in MM Hills forests. Moreover, the importance of WFPs for future food security, to achieve nutritional food for all, health, and more importantly, strengthens the socio-economic and cultural fabrication between communities. The study also serves as a baseline for future research on sustainable use of WFPs, in-depth studies on nutritional and medicinal properties, and the economics and cultural aspects of plant use.

Declarations

Ethics approval and consent to participate: All the participants provided prior informed consent before the interviews.

Availability of data and materials: Data are available from the first author.

Competing interests: The authors declare that they have no competing interests.

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Author contributions: RPH and GR carried out the field study. RPH and GR wrote the manuscript. RPH contributed to specimen identification. RPH and SSR thoroughly revised the manuscript. All authors read and approved the final manuscript.

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Appendix 1. List of Wild Food Plants Recorded in the Forest and Farmlands in MM Hills

Family/species	Folk name	Life forms	Part used	Habitat (Source)	Harvest season	Use index
Acanthaceae						
Blepharis maderaspatensis (L.) B. Heyne ex Roth	Kolikalu soppu	Herb	Leaf & shoot	Forest	Rainy	0.19
Amaranthaceae						
Alternanthera sissilis (L.) R. Br.	Angone soppu	Herb	Leaf & shoot	Wet ands	Rainy	0.04
Alternanthera pungens Kunth.	Negalu sanmullu	Herb	Leaf & shoot	Agri & fallow	Rainy	0.45
Celosia argentea L.	Anne soppu	Herb	Leaf & shoot	Agri lands	Rainy	1.00
Amaranthus tristis	Bilikeere soppu	Herb	Leaf & shoot	Agri lands	Rainy	0.57
Amaranthus polygonoides	Dagalikeere soppu	Herb	Leaf & shoot	Fallow lands	Rainy	0.47
Digera arvensis	Gorji soppu	Herb	Leaf & shoot	Agri lands	Rainy	0.07
Gramphrina celosoides	Kalluanne soppu	Herb	Leaf & shoot	Agri & fallow	Rainy	0.20
Amaranthus caudatus L.	Kempukeere soppu	Herb	Leaf & shoot	Agri lands	Rainy	0.48
Amaranthus spinosus L.	Mullkeere soppu	Herb	Leaf & shoot	Agri & fallow	Rainy	0.07
Amaranthus viridis L.	Silkere soppu	Herb	Leaf & shoot	Home garden	Rainy	0.93
Achyranthus aspera L.	Uthrani soppu	Herb	Leaf & shoot	Agri & fallow	Rainy	0.58
Anacardiaceae						
Buchanania lanzan Sprengel	Doda murki	Tree	Fruit	Forest	Rainy	0.28
Semecarpus anacardium L. f.	Geru	Tree	Fruit	Forest	Rainy	0.14
Buchanania axillaris Ramam.	Murki	Tree	Fruit	Forest	Winter	0.08
Rhus mysorensis G.Don	Visha mulike	Shrub	Fruit	Forest	All season	0.21
Mangifera indica L.	Thoremavu	Tree	Fruit	Forest, Agri & backyard	Summer	1.00
Annonaceae						
Miliusa velutina (Dunal) J.	Hesare	Tree	Fruit	Forest	Rainy	0.52
Annona squamosa L.	Setaphal	Tree	Fruit	Forest & Agri	Rainy	0.76
Annona reticulata L.	Ramphal	Tree	Fruit	Agri & Backyard	Rainy	0.38
Apiaceae						
Centella asiatica (L.)Urban	Ondelaga	Herb	Leaf & shoot	Wet lands	Summer	0.66

Apocynaceae						
Carissa carandas L.	Kevali	Shrub	Fruit	Agri & fallow	Winter	0.63
Araceae						
Coloasia esculenta (L.) Schott	Sebu	Herb	Shoot	Wetlands	Rainy	0.26
Aracaceae						
Pheonix loureirii Kunth	Eachalu	Shrub	Shoot & fruit	Forest	All season	0.47
Asclepiadaceae						
Dacalepsis hamiltoni L.	Makali	Climber	Root	Forest	Winter-Summer	0.24
Hemidesmus indicus R. Br.	Sogade beru	Climber	Root	Forest,Agri & fallow	All season	0.73
Caralluma umbellata	Mandgalli	Herb	Shoot	Forest,Agri & fallow	Rainy	0.59
Ceropegia tuberosa	Mathadaka	Climber	Root	Forest	Rainy	0.41
Asparagaceae						
Asparagus gonocladus Basker.	Sipre	Climber	Root	Forest,Agri & fallow	Summer-rainy	0.49
Astraceae						
Sonchus asper (L.) Hill	Alsoppu	Herb	Leaf & shoot	Forest & Agri	Rainy	0.85
Glossocardia bosvallia (L.f.) DC.	Ajji soppu	Herb	Leaf & shoot	Forest,Agri & fallow	Rainy	0.35
Taraxacum officinale	Nelathanga	Herb	Leaf & shoot	Forest & Agri	Rainy	0.19
Basellaceae						
Anredera vesicaria C.F. Gaerth.	Kadubasale	Climber	Leaf & shoot	Forest & backyard	Rainy	0.62
Basidiomycetes (Fungi)						
Agaricus bisporus	Ane Anabe	Herb	Whole plant	Forest,Agri & fallow	Rainy	0.58
Agaricus campestris	Motte anabe	Herb	Whole plant	Forest,Agri & fallow	Rainy	0.64
Agaricus spp.	Koli Anabe	Herb	Whole plant	Forest,Agri & fallow	Rainy	0.51
Boraginaceae						
Cordia wallichii G. Don	Solle kudi	Tree	Leaf, shoot & fruit	Forest	Summer	0.27
Cactaceae						
Opantia elatior Mill.	Kalli hannu	Shrub	Fruit	Forest & Agri	Rainy	0.08

Caesalpinaceae						
Tamarindus indica L.	Hunase	Tree	Leaf flower & fruit	Forest,Agri & fallow	All season	1.00
Cassia occidentalis L.	Nayiuri soppu	Shrub	Leaf & shoot	Agri & fallow	Rainy	0.56
Senna hirsuta (L.) H.S. Irwin & Barneby	Thangadi	Shrub	Leaf & flower	Agri & fallow	Summer-Rainy	0.28
Pithecellobium dulce (Roxb.) Benth.	Seemehunse	Tree	Fruit	Forest,Agri & fallow	Summer	0.62
Senna obtusifolia (L.) H.S. Irwin & Barneby	Thagase	Herb	Leaf & shoot	Forest,Agri & fallow	Rainy	0.69
Caryophyllaceae						
Stellaria media (L.) Vill.	Seeranage	Herb	Leaf & shoot	Forest & Agri	Rainy	0.16
Chenopodiaceae						
Chenopodium album L	Megatike	Herb	Leaf & shoot	Forest & Agri	Rainy	0.19
Clemoaceae						
Cleome monophylla L.	Sataga	Shrub	Leaf & shoot	Agri lands	Rainy	0.72
Cleome gynandra L.	Narubele soppu	Herb	Leaf & shoot	Forest,Agri & fallow	Rainy winter	0.66
Commelinaceae						
Commelina benghalensis Burm.	Kanne soppu	Herb	Leaf & shoot	Agri lands	Rainy	0.43
Costaceae						
Costus speciosus (Koenig)Smith	Halugenasu	Climber	Root	Forest & Agri	Rainy	0.15
Cucuerbitaceae						
Diplocyclos palmatus (L.) Jeffrey	Lingathonde	Climber	Leaf & shoot	Forest & Agri	Summer-rainy	0.13
Coccinium grandis (L.) J.Voigt.	Kadu thonde	Climber	Leaf & fruit	Forest & Agri	Rainy	0.83
Cucumis callosus	Minike hannu	Climber	Fruit	Agri lands	Rainy	0.26
Dioscoreaceae						
Dioscorea oppositifolia L.	Benne	Climber	Root	Forest	Winter-Summer	0.73
Dioscorea pentaphylla L.	Noore	Climber	Root	Forest	Winter-Summer	0.82
Dioscorea bulbifera L.	Kalbenne	Climber	Root	Forest	Winter-Summer	0.30
Ebanaceae						
Dispyrous mantana Roxb.	Jagalganti kudi	Tree	Leaf & shoot	Forest	Rainy	0.10
Diospyros melanoxylon Roxb.	Thupre	Tree	Fruit	Forest	Rainy	0.33

Erythroxylaceae						
Erythroxylum monogynum Roxb.	Chumbulse	Tree	Fruit	Forest	Rainy	0.26
Euphorbiaceae						
Euphorbia heyneana	Avane soppu	Herb	Leaf & shoot	Agri & fallow	Rainy	0.57
Phyllanthus emblica L.	Nelli	Tree	Fruit	Forest	Winter-summer	0.93
Phyllanthus indofischeri L.	Dodanelli	Tree	Fruit	Forest	Winter-summer	0.97
Fabaceae						
Indigofera linifolia (L.f.) Retz.	Marali kudi	Shrub	Leaf & flower	Forest	Summer-Rainy	0.20
Erythrina sp.	Vayurani	Tree	Leaf & shoot	Forest & Agri	Rainy	0.14
Flacourtaceae						
Scolopia crenata (W. & A.) Clos.	Doddgejjalike	Tree	Fruit	Forest	Rainy-Winter	0.19
Flacourtia indica (Burn.) Merr.	Gejjalike	Tree	Fruit	Forest	Winter-summer	0.11
Flueggea leucopyrus	Sulihannu	Tree	Fruit	Forest	Summer-Rainy	0.39
Flacourtia sp.	Ambulse hannu	Climber	Fruit	Forest	Summer	0.17
Lamiaceae						
Plectranthus amboinicus (Lour.) Spreng.	Chendimari	Herb	Leaf & shoot	Forest & Agri	Rainy	0.18
Meriandra bengalensis (Roxb.) Benth.	Biligundi soppu	Herb	Leaf & shoot	Forest & Agri	Rainy	0.33
Malvaceae						
Abutilon indicum (L.) Sweet	Pettige soppu	Shrub	Leaf & shoot	Forest,Agri & fallow	Rainy	0.2
Menispermaceae						
Holostemma annulare (Roxb.) K.	Muste soppu	Climber	Leaf & shoot	Forest & Agri	Rainy	0.82
Cocculus Hirsutus (L.) DIELS.	Javne soppu	Climber	Leaf & shoot	Forest,Agri & fallow	Rainy	0.52
Cocculus villosus	Doddajavane	Climber	Fruit	Forest & Agri	Summer	0.21
Mimosaceae						
Acacia farnesiana (L.) Willd.	Seege soppu	Shrub	Leaf & shoot	Forest,Agri & fallow	Summer-Rainy	0.89
Acacia concinna (Willd.) DC.	Thaleseege	Climber	Leaf & shoot	Forest & Agri	Summer-Rainy	0.43
Molluginaceae						
Mollugo pentaphylla L.	Murali soppu	Herb	Leaf & shoot	Agri lands	Rainy	0.42

Moraceae						
Ficus racemosa L.	Athi	Tree	Fruit	Forest & Agri	All season	0.59
Ficus benghalensis L.	Alada ahnnu	Tree	Fruit	Forest & Agri	All season	0.26
Moringaceae						
Moringa oleifera Lam. (wild variety)	Kadunugge	Tree	Leaf & shoot	Forest	Rainy	1
Myrtaceae						
Syzygium cumini (L.) Skeels	Nerale	Tree	Fruit	Forest & Agri	Rainy	1
Syzygium jambos (L.) Alst.	Jambunerale	Tree	Fruit	Forest & Agri	Rainy	1
Nymphaceae						
Nymphaea nouchali Burm. f.	Thavare dantu	Herb	Shoot	Wet lands	All season	0.21
Nyctaginaceae						
Boerhavia diffusa L.	Katte soppu	Herb	Leaf & shoot	Agri & fallow	Rainy	0.89
Oleaceae						
Jasminum ritchiei Cl.	Kaddi soppu	Shrub	Leaf & shoot	Forest,Agri & fallow	All season	1
Oxalidaceae						
Oxalis corniculata L.	Hulisoppu	Herb	Leaf & shoot	Wet lands	Rainy	0.7
Passifloraceae						
Passiflora edulis Sims.	Juice fruit	Climber	Fruit	Agri & Backyard	All season	0.44
Plumbaginaceae						
Plumbago zeylanica L.	Kudugalhidi soppu	Herb	Leaf & shoot		Rainy	0.37
Poaceae				Forest,Agri & fallow		
Bambos arundinacea Retz.	Bamboo	Tree	Shoot	Forest	Rainy	1
Dendrocalamus strictus Nees.	Chit bidaru	Tree	Shoot	Forest	Rainy	1
Polygonaceae						
Polygonum barbatum L.	Naravalu	Shrub	Leaf & shoot	Forest & Agri	Rainy	0.12
Portulacaceae						
Portulaca quadrifida L.	Belawadake soppu	Herb	Leaf & shoot	Agri lands	Rainy	0.63

Rhamnaceae						
Ziziphus mauritiana Lam.	Elachi	Tree	Fruit	Forest	Winter	0.75
Ziziphus oenoplia (L.) Mill.	Hulisodli	Climber	Fruit	Forest	Rainy	0.82
Ziziphus rugosa Lam.	Gotti	Tree	Fruit	Forest	Rainy	0.29
Zizyphus Sp.	Ambudotti hannu	Climber	Fruit	Forest	Rainy	0.27
Rosaceae						
Rubus niveus	Komali hannu	Climber	Fruit	Forest	Rainy-winter	0.73
Rubiaceae						
Canthium parviflorum Lam.	Kare soppu	Shrub	Leaf, shoot & fruit	Forest & Agri	Rainy-winter	1.00
Morinda citrifolia L.	Mddimara	Tree	Fruit	Forest	Rainy-Winter	0.53
Pavetta indica L.	Pavatige	Tree	Fruit	Forest	Rainy	0.26
Canthium dicoccum	Therani hannu	Tree	Fruit	Forest	Rainy	0.44
Rutaceae						
Limonia acidissima L.	Byala	Tree	Fruit	Forest,Agri & fallow	Winter-Summer	0.83
Toddalia asiatica (L.) Lam.	Kadumensau kudi	Climber	Leaf & shoot	Forest	Summer-Rainy	0.61
Salvadoraceae						
Scutia myrtina Kurz.	Batsodli	Climber	Fruit	Forest & fallow	Rainy	0.79
Scrophulariaceae						
Bacopa monnieri (L.) Wettst.	Goni soppu	Herb	Leaf & shoot	Wet lands	Rainy	0.48
Sapinadaceae						
Aglaia elaeagnoidea (A. Juss.) Benth	Gudagan jagadi	Tree	Fruit	Forest	Rainy	0.66
Schleischera oleosa (Lour.) Oken	Hulijagadi	Tree	Fruit	Forest & Agri	Rainy	0.79
Sapotaceae						
Manilkara hexandra (Roxb.) Dubard	Kalpale hannu	Tree	Fruit	Forest	Summer	0.23
Mismusops elengi L.	Pokla	Tree	Fruit	Forest	Rainy	0.31
Solanaceae						
Solanum nigricum L.	Ganake soppu	Herb	Leaf, shoot & fruit	Agri, fallow & backyard	Summer-Rainy	1
Solanum arcanum L:	Gul tamate	Herb	Fruit	Agri, fallow & backyard	Rainy	0.74

Solanum xanthocarpum L.	Gulkai	Shrub	Fruit	Agri, fallow & backyard	All season	0.34
Solanum torvum Sw.	Paraval sunde	Shrub	Fruit	Agri, fallow & backyard	Rainy	0.44
Solanum trilobatum L.	Mullu sunde	Shrub	Fruit	Forest & Agri	Rainy	0.78
Solanum erianthum D. Don.	Sunde	Shrub	Fruit	Forest	Rainy	0.92
Physalis angulata L.	Nipatte hannu	Herb	Fruit	Agri lands	Rainy	0.68
Tiliaceae						
Grewia tiliifolia Vahl,.	Thadasalu hannu	Tree	Fruit	Forest	Rainy	0.65
Grewia hirsuta Vahl.	Esygirke	Shrub	Fruit	Forest & Fallow	Winter-Summer	0.3
Grewia orbiculata	Udhupe	Tree	Fruit	Forest	Rainy-Winter	0.14
Grewia bracteata Heyne ex Roth.	Kothipiduka	Shrub	Fruit	Forest & Fallow	Rainy-Winter	0.11
Grewia Sp.	Kadukalle	Shrub	Fruit	Forest,Agri & fallow	Rainy-Winter	0.17
Vitaceae						
Cissus quadrangularis L.	Narale	Climber	Leaf & shoot	Forest,Agri & fallow	Rainy	0.89
Cayratia Sp.	Alekudi	Climber	Leaf & shoot	Forest,Agri & fallow	Rainy	0.37
Zygophyllaceae						
Tribulus terrestris L.	Naggalu kudi	Herb	Leaf & shoot	Forest,Agri & fallow	Rainy	0.62

Appendix 2. Therapeutic use of WFPs

Botanical Name	Part Used	Relative Frequency Citation	Culinary Use	Therapeutic Use
Acacia farnesiana (L.) Willd.	Leaf & shoot	0.419	Salad, Pan-fried snacks	Anemic and skin diseases
Achyranthus aspera L.	Leaf & shoot	0.249	Salad, Pan-fried snacks	Antiseptics
Alternanthera sissilis (L.) R.Br.	Leaf & shoot	0.381	Salad, Pan-fried snacks	Anemic and eyesight
Asparagus gonocladus Basker.	Tuber	0.311	Salad, Pan-fried snacks	Fever
Bacopa monnieri (L.) Wettst.	Leaf & shoot	0.369	Salad, Pan-fried snacks	Stress & memory
Bambos arundinacea Retz.	Shoot	0.598	Salad	Wound healing
Boerhavia diffusa L.	Leaf & shoot	0.402	Salad, Pan-fried snacks	Blood pressure
Buchanania lanzan Sprengel	Fruit	0.311	Fresh fruit	Fatigue & digestion
Canthium parviflorum Lam.	Fruit & leaves	0.311	Fresh fruit & salad	Dysentery/Acidity
Caralluma umbellata	Shoot	0.250	Fresh shoot	Diabetes
Celosia argentea L.	Leaf & shoot	0.587	Salad, Pan-fried snacks	Headache, cold
Centella asiatica (L.) Urban	Leaf & shoot	0.287	Fresh leaves & Salad	Jaundice, Anxiety & Wound healing
Cissus quadrangularis L.	Leaf & shoot	0.327	Salad, Pan-fried snacks	Bone fracture
Cleome gynandra L.	Leaf & shoot	0.369	Salad, Pan-fried snacks	Acidity, dizziness
Cocculus Hirsutus (L.) Diels.	Leaf & shoot	0.413	Salad, Pan-fried snacks	Reducing body heat
Coloasia esculenta (L.) Schott	Leaf & shoot	0.311	Salad, Pan-fried snacks	Kidney stone
Commelina benghalensis Burm.	Leaf & shoot	0.327	Salad, Pan-fried snacks	Anti-inflammatory/ulcer
Dacalepsis hamiltoni L.	Tuber	0.419	Liqueurs, pickle	Stomach disorders, gastric ulcers
Dioscorea bulbifera L.	Tuber	0.287	Pan-fried snacks	Cholera/ diarrhea
Grewia hirsuta Vahl.	Fruit & Root	0.250	Fresh fruit & Liqueurs	Bone fracture
Hemidesmus indicus R. Br.	Tuber	0.419	Liqueurs	Acidity, dizziness
Jasminum ritchiei Cl.	Leaf & shoot	0.342	Salad, Pan-fried snacks	Dysentery/Acidity
Limonia acidissima L.	Fruit & bark	0.316	Fresh fruit	Fever
Manilkara hexandra (Roxb.) Dubard	Fruit & bark	0.311	Fresh fruit & Liqueurs	Back pain & Body pain
Oxalis corniculata L.	Leaf & shoot	0.283	Pan-fried snacks	Eye treatment
Phyllanthus emblica L.	Fruit	0.340	Fresh fruit, pickle, liqueurs	Immune development, ulcer
Plumbago zeylanica L.	Leaf & shoot	0.283	Salad, Pan-fried snacks	Muscular pain and rheumatic diseases
Semecarpus anacardium L. f.	Fruit	0.365	Fresh fruit	Anti-inflammatory, hair growth
Solanum erianthum D. Don.	Fruit	0.287	Fresh and dry fruit	Diabetes
Solanum nigricum L.	Fruit	0.377	Salad, Pan-fried snacks	Ulser
Solanum trilobatum L.	Fruit	1.287	Fresh and dry fruit	Cold and cough
Sonchus asper (L.) Hill	Leaf & shoot	0.254	Salad, Pan-fried snacks	Boils & wounds
Syzygium jambos (L.) Alst.	Fruit & bark	0.342	Fresh fruit	Dysentery/Acidity
Toddalia asiatica (L.) Lam.	Leaf & shoot	0.322	Salad, Pan-fried snacks	Stomachache and indigestion
Tribulus terrestris L.	Leaf & shoot	0.309	Salad, Pan-fried snacks	Heart pain