Knowledge, attitudes and practices (KAP) of rural women in the dry zone of Sri Lanka on underutilized vegetable crops

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Research

Abstract

Background: Underutilized vegetables are those plant species with potential food and medicinal uses, and contributing to the socio-economic welfare of the rural communities. However, they are underexploited. These plants play a vital role in rural communities, particularly for the women, in food supply and preparation and thus contributing to dietary variations and food security in households. The present study was conducted to investigate the knowledge, attitudes and practices on underutilized vegetables by rural women in selected village communities in the Dry Zone of Sri Lanka.

Methods: A total of 328 respondents comprising of rural women were randomly selected from four villages in Mahailluppallama irrigation block of the Mahaweli zone H in the Dry Zone of Sri Lanka. Primary data were collected through face-to-face interviews using an interview schedule and also the direct observations.

Results: Seventy-nine (79) underutilized vegetable species were reported to be consumed by the respondents as a part of their normal diet. However, 20 of them were least consumed due to factors such as lack of interest among the younger generation, lack of availability, lack of awareness, and inadequate knowledge on their preparation as a food item. Women play the major role in collecting, preparing and related decision making on underutilized vegetables.

Conclusions: A considerable diversity of underutilized vegetables exist in the community. However, some of them were less consumed and were not available in adequate quantities. Measures should be taken to popularize and conserve underutilized vegetables. Documentation of information is also important for sustainable use and exploring the future potential.

Keywords: Underutilized Vegetables, Medicinal Values, Food Preparations, Conservation, Women, Sri Lanka

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Background

Zero hunger is the 2nd United Nations Sustainable Development Goal (UNSDG) that the member countries are committed to achieve by 2030 (Jorgensen & Costanza 2016). The targets include sustainable food production through resilient agricultural practices that maintain ecosystem sustainability. It also includes maintaining the genetic diversity of seeds, cultivated plants and their related wild species, ensuring equitable sharing benefits of genetic resources and associated knowledge and thus preventing from the extinction (FAO 2019).

World's population is expected to increase up to 9.6 billion by 2050 (Gerland *et al*. 2014). Increased

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population will lead to increase in demand for foods, threatening agricultural sustainability (Chen *et al*. 2016, Farooq *et al*. 2019, Lewis & Nocera 2006,). At present, about 690 million people in under-developed nations are unable to meet their daily food intake (FAO 2020), especially in the Asian and African regions (Porter *et al.* 2014). Majority of preschool children from countries of this region suffer from energy deficiencies and malnutrition (Pinstrup-Andersen 2007).

Food requirement of the contemporary world is met primarily through limited number of species such as rice, wheat and maize. Other crop species that can contribute significantly as food in a nutrient-rich diet receive little attention (Williams & Haq 2002). Currently, more than 7,000 species are neglected (Ulian *et al*. 2020). According to Reeves (2016), half of the global requirement for protein and carbohydrates are provided by rice, maize, and wheat, resulting in unbalanced diets leading to obesity and malnutrition among people. This situation is expected to worsen further in the future with increasing population and consequences of global climate change. Sri Lanka is not an exception. The economic growth of Sri Lanka has been slower in the recent past especially in the agricultural sector (CBSL 2009, CBSL 2019), with an increasing trend in poverty and hunger mainly in the rural areas. Population growth and urbanization is expected to increase further with the increased demand for food. This will also lead to less land availability for cultivation, further increasing the pressure on agricultural lands resulting in poor land management and enhanced degradation. Therefore, meeting the increasing demand for food in an environmentally friendly manner will be one of the major challenges to be faced by Sri Lanka.

Sri Lanka is a lower-middle-income earning island nation with approximately 21.8 million people living in a total area of 65, 610 km^2. Population density is about 348/ km^2 (CBSL 2019). About 18.2 percent of the population is urban, 77.4% in rural areas and 4.4% in the state sector (CPH 2015). Being a tropical country located in the low latitudes between 6^0 and 10^0 N in the Indian Ocean, Sri Lanka shows a typical maritime- tropical climate (Punyawardena 2008). The country is divided into three climatic zones namely, Wet, Intermediate and Dry Zones, based on the spatial distribution of the annual rainfall.

Despite the relatively small land mass, Sri Lanka has been identified as a country rich in biodiversity (Muthukudaarachchi & Wijeratne 2007). It also has a wide range of agro-biodiversity including neglected and underutilized crop genetic resources. The majority of elements of biodiversity are edible and nutritious, yet neglected in terms of cultivation and use. Nevertheless, they would be much important to ensure the future food and nutritional security of Sri Lankan community particularly in rural areas. These underutilized crops, which are predominantly fruits and vegetables, are considered to be sources of vital micronutrients with many health benefits. They also have great economic potential and agronomic advantages including attributes such as climate resilience (Malkanthi 2017, Ranil *et al,* 2021).

Underutilized plant species often have ability to tolerate harsh climatic conditions and resist pest and disease manifestations. Thus, they offer a great opportunity for climate change adaptation. Moreover, they could contribute to food security and poverty alleviation, consequently reducing malnutrition within the rural communities. However, modern agriculture favors few cash crops that generate attractive income within a short time period. This in turn leads to the neglect of remaining crops and lowering of the utilization of plant genetic diversity (Dansi *et al*. 2012). Therefore, genetic erosion has become intensive (Williams 2002). Underutilized crops are generally found in many agricultural ecosystems, fallow lands, along the irrigation channels, roadsides, home gardens, and also from natural forests in Sri Lanka. These crops had been regularly used by the indigenous communities for many years in their diet especially during famines and lean seasons (Williams 2002). They have multiple uses in the food ways including staple, appetizer, gruel, soups, beverages, dessert, snacks, and source for medicinal purposes.

Despite the diversity and consumption of underutilized crops in Sri Lanka, there is a scarcity of information on their geographical distribution, and nutritional, medicinal and other phytochemical properties, as well as their potential to enhance the economic status of the rural communities. Moreover, the indigenous knowledge associated with underutilized vegetables (UVs) still remain as personal memories within the rural society. Such knowledge on UVs with respect to their food and medicinal uses has not been properly explored and documented, where the knowledge repositories are mainly with the rural women having associated with food preparation (Aluko 2018, Howard 2003) and family health (Ibnouf 2012).

The concept of cultural eco-feminism explains the unique relationship between women and nature (Tiondi 2000), which can be used in managing natural resources, particularly UVs. Ethnobiological knowledge and practice of rural women in plants are important features as they are considered as the main managers of plant diversity through wild food

gathering, agro-biodiversity conservation, natural resource management, and therefore the transmission and conservation (Howard & Cuijpers 2002, Pfeiffer & Butz 2005). Their traditional knowledge on plants is important in promoting food diversity and healthy food systems in ethno nutrition while contributing to policies protecting plant biodiversity. Moreover, it helps to make conservation plans on existing structures of local knowledge (Kuhnlein 2014, Padmanabhan 2011). Fonjong (2008), argues that women are critical both as agents and as victims of natural resource exploitation and management and therefore, gender mainstreaming is especially important for successful management of natural resources in developing countries. Hence, investigation and documentation of knowledge, attitude, and practices (KAP) of women with regards to UVs is of national and global significance in designing the present study. Such an exercise is a necessity prior to these communities moving out of their traditional lifestyle, and to highlight the role of women with respect to UVs in the Dry Zone of Sri Lanka. The specific objective was to make recommendations and suggestions for conservation and potential use of UVs, where the traditional and modern scientific knowledge together is a powerful tool to achieve the country's development goals, establishing sustainable food systems and targeting long term food security.

Methods

Study area

The study was conducted in the Mahailluppallama block of the Mahaweli Zone H in the Anuradhapura district in the low-country Dry Zone (Agri-Ecological Region DL1b) of Sri Lanka. The Mahaweli development project (MDP) is the largest multi-purpose rural development program in the country. It was undertaken by diverting water from the longest river 'Mahaweli' towards the Dry Zone with the objective of increasing the agricultural production and thereby improving the livelihoods of the rural community (Wickramaarachchi & Wijesekera 2001). Mahaweli system H is the oldest system of the MDP (Aheeyar *et al*. 2007). Annual rainfall of the area has varied from 1,010 mm to 2064 mm during the past ten years with 124 annual rainy days in 2019 (CBSL 2019). The consecutive few months of no or less rain is experienced normally from May to September and major rainfall is received by the northeast monsoon that usually comes from December to February. Reddish Brown Earth (RBE) and the Low Humic Gley (LHG) are the main soil groups in the area. Agriculture is the main livelihood of people living in the study area with paddy and mixed home gardens as common land uses.

Field survey and data collection

A field survey was conducted in four selected villages (Figure: 1) in Mahailuppallama block of the Mahaweli zone H in the Dry Zone of Sri Lanka, namely Senapura, Katiyawa, Dikwewa, and Dangollagama.

A total of 328 women from rural households in the four study villages were selected by simple random sampling technique to collect primary data through interviews and observations. All households in the study area were considered as the sampling frame (1180) and a number was assigned to each of the household. Then, 330 households were elected using a scientific calculator (random number generator). Two households were eliminated since there were no women in those households. The interviews were conducted using a structured interview schedule to collect information on UVs that are consumed and/or familiar to the respondents. The interview schedule was structured to collect information on the background, knowledge, attitudes, and practices. The information on age, family type, education, occupation, annual household income and the land ownership were collected under the background section. The ability to identify UVs by their common name was considered as the indicator of the knowledge on UVs. The attitudes were measured using nine statements (Table 4), given in a five-point Likert scale as 'strongly agree', 'agree', 'neutral', 'disagree' and 'strongly disagree'. The data on reasons for consumption of UVs, decision making on meal preparation in the household, person responsible for collecting/ procuring UVs for the household, medicinal use and food preparation methods were collected under the practices section.

Identification of plant species

Specimens and photographs were used for identification of species. Most of the common and familiar species were botanically identified at the field and further confirmed using herbarium specimens and relevant literature of flora of Sri Lanka. For the identification of unknown species, specimens were collected according to the standard herbarium techniques. Moreover, apart from their botanical characteristics, some supportive information, such as common names, different uses, period of flowering and fruits, special habitat characteristics were also collected and documented. Collected specimens were tagged and preserved at the Agricultural museum and herbarium, Mahailuppallama Sub Campus, University of Peradeniya, Sri Lanka. Such specimens were botanically identified with the help of standard identification keys, reference herbarium specimens and in consultation with the experts in the field.

Identified species were categorized and presented with their botanical families, common names, species status and used parts (Appendix 01).

Documentation and data analysis

The data obtained were tabulated and analyzed through descriptive statistics (frequency, percentages) to interpret the results. The inventory was developed for underutilized vegetable species for the surveyed area.

Results and discussion

Socio-economic profile of the respondents

The 328 respondents varied in their age, family type, education, occupation, and income (Table: 1), and 50% of the respondents were in the age category of 36-55 years. The results revealed that 67% of the respondents have studied up to General Certificate of Education (GCE A/L; up to year 13 in school) and among them, the majority (76%) were housewives engaged in full-time farming. About 94% of the respondents had their own lands and only 4% and 2% had leased lands and encroached lands respectively. However, only 21% have visited common lands (road sides, bunds of the lakes, small woodlands, fallow lands, etc.) to collect UVs. The majority of the respondents were not interested in doing so, as most of the UVs are commonly available in their own lowlands and uplands. Further, some of the respondents were of the opinion that collecting UVs from common lands reflects poorly on their social standing. In other words, it was considered as poor people's practice.

Knowledge of the respondents on underutilized vegetables

Seventy-nine (79) underutilized vegetable species belonging to 41 plant families were identified by the respondents (Table 2). This is a considerable number when compared to the total diversity of food crops in the Dry Zone agricultural systems of Sri Lanka. This also indicates their tremendous interaction with the natural environment and the agricultural ecosystems. According to Modi *et al*. (2006), rural people engage with their surrounding for farming and other day today activities, and they gain some traditional knowledge on underutilized vegetables from their peers and personal experience. Among the species identified, 57 species were native, 15 cultivated, and five species were naturalized. *Argyreia populifolia* Choisy and *Solanum macrocarpon* L. were the only endemic and introduced species, respectively, reported in the study area. The complete list of UVs with their vernacular names are given in Appendix 1. The majority of the respondents particularly educated women (above GCE Advanced level, 91%) were aware of the health benefits of identified UVs. About 89% of the respondents reiterated that UV are organic and 84% claimed that these vegetables are freely/naturally available in their day-to-day life. Moreover, 81% people were knowledgeable on UVs since their taste.

Table 2 shows the comparison of diversity of UVs among the four villages. Based on the information gathered from the respondents and taking into account the types of species listed in the survey, diversity of UVs marginally varied among four villages (Table 2). This may be due to the four selected villages are closely located with similar geographical and agro-ecological characteristics. When the ecological conditions are alike, adjacent areas tend to have same types of UVs (Reyes-Garcia *et al*. 2007). Moreover, it could also indicate the social and cultural similarities among villages. Most of the village dwellers are relatives and have close relationship that helps to exchange their traditional knowledge on plants. There is a possibility of existence of more species that have not reported or not familiar to the respondents.

The number of species listed per respondent varies from 1-24 (Figure 1). About 85% of the respondents listed 4-5 species; they were fulltime farmers. With that, 217 respondents (66%) who are above age 35 years listed 4-9 species while only seven (2%) listed more than 20 species which were reported as old farmers and house wives. Furthermore, the maximum number of species listed per person was 24. A variation visible in the number of species identified is because of the respondents' demographic characteristics in terms of their education level and engagement with the surrounding environment (Ntawuruhunga *et al*. 2020). Those who are directly engaged with the environment because of the occupation (farming and other agricultural related activities) show relatively high knowledge about their environment and indigenous plants (Hossain & Hasan 2018, Franco & Minggu 2019).

From the species listed by the respondents, five species namely *Coccinia grandis* (L.) Voigt, *Trianthema portulacastrum* L, *Cheilocostus speciosus* (J.Koenig) C.D.Specht, *Lasia spinosa* (L.) Thwaites, and *Canavalia ensiformis* (L.) DC. (A, B, C, D, and E, respectively in Figure 2) appeared as the commonly available in the surrounding areas and year-round and most wildly known and consumed. Furthermore, 68% of respondents possessed knowledge on different kinds of preparations utilizing these crops.

Table 1. Socioeconomic characteristics of respondents (n=328)

Demographic characteristics		**Respondents %**
Age	Less than 25 years	2
	26-35 years	16
	36-55 years	50
	More than 55 years	32
Family type	Nuclear family	83
	Extended family	17
Education	Up to GCE (Ordinary level)	32
	Up to GCE (Advanced level)	67
	Diploma	0.6
	Degree	0.4
Occupation	House wives (full time engagement in farming)	76
	Government sector employees	10
	Private sector employees	05
	Small businesses	09
Annual household income	Less than- 2743.42$	76
	2743.42-5486.84	21
	5486.84-10973.68	2
	More than -10973.68$	1

Table 2: Comparison of UVs diversity among four villages

Criteria	***Senapura***	***Katiyawe***	***Dikwewa***	***Dangollagama***	**Total**
Number of families	33	32	27	29	**41**
Number of genera	57	44	41	43	**67**
Number of species	60	45	41	44	**79**
Number of native species	53	38	35	39	**57**
Number of cultivated species	6	5	4	3	**15**
Number of naturalized species	1	2	2	2	**5**
Number of Introduced species	1	-	-	-	**1**
Number of endemic species	1	-	-	-	**1**

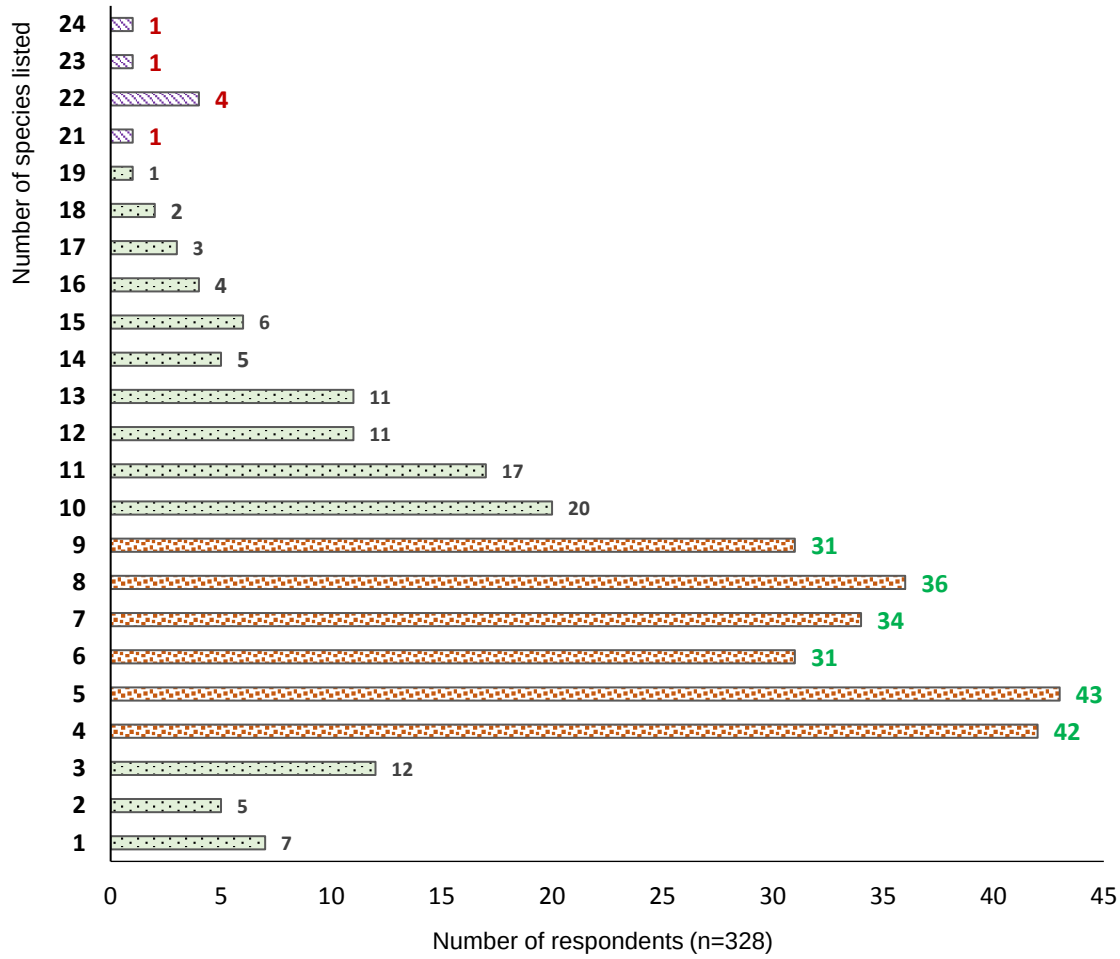

Figure 1: Number of species listed by respondents

Of all UVs reported, there were 20 UVs identified as the least consumed (less than 3 %) and rarely consumed vegetables by the respondents (Table 3), which could be attributed to the rare occurrence of such species due to seasonal availability and inadequate knowledge about their food preparations. Many of those crops could be highly nutritious and have medicinal values with an immense potential for cultivation and utilization. According to the responses, few crops were recognized as underutilized. These crops are usually cultivated on largescale mainly for fruits or pods. The immature leaves of *Moringa oleifera* Lam., *Manihot esculenta* Crantz, *Psophocarpus tetragonolobus* L. (DC.) and *Passiflora edulis* Sims. were used as leafy vegetables. Furthermore, Avocado leaves (*Persea americana* Mill.) are used to make porridge, and banana (*Musa* spp.) pseudo stem are used to make curries. The results revealed that some plant parts of the commercially cultivated species are edible but underutilized.

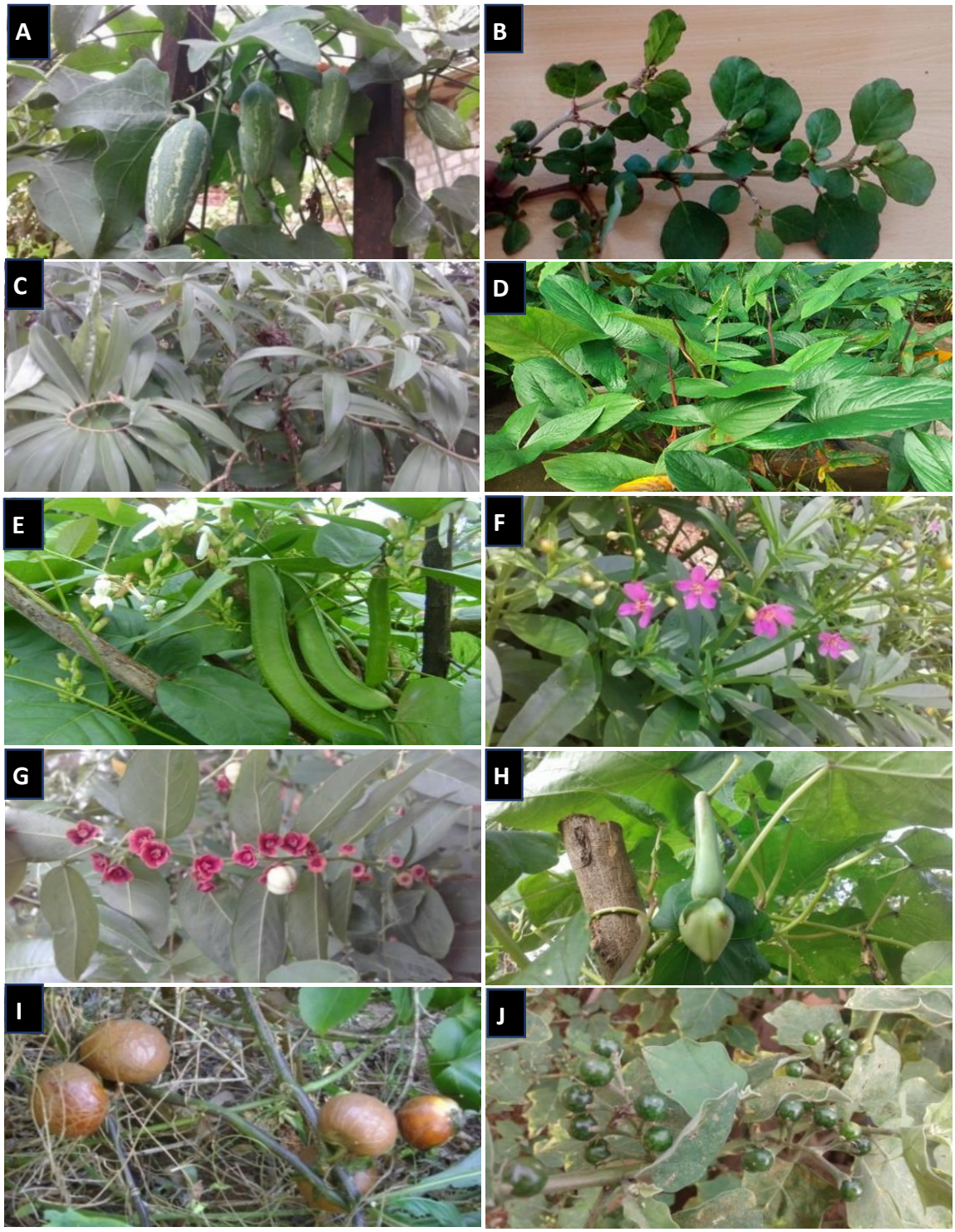

Figure 2: Selected underutilized vegetable species recorded during the survey: **A:** *Coccinia grandis,* **B:** *Trianthema portulacastrum,* **C:** *Cheilocostus speciosus,* **D:** *Lasia spinosa,* **E:** *Canavalia ensiformis,* **F:** *Talinum paniculatum,* **G:** *Sauropus androgynous,* **H:** *Ipomoea alba,* **I:** *Solanum macrocrpon*, **J:** *Solanum violaceum*.

Table 3: Least consumed UVs by the respondent

Botanica Name	Common Name	Consumption%
Polyalthia korinti (Dunal) Thwaites	Ul-kenda	0.1
Olax zeylanica L.	Malla	0.3
Cycas nathorstii J. Schust.	Madu	0.6
Dregea volubilis (L.f.) Benth. ex Hook.f.	Kiri anguna	0.6
Hygrophila auriculata (Schumach.) Heine	Ikiriya	0.6
Careya arborea Roxb.	Kahata	0.9
Bacopa monnieri (L.) Wettst.	Lunuwila	1.2
Monochoria hastata (L.) Solms	Diya-habarala	1.2
Dioscorea esculenta (Lour.) Burkill	Kukulala	1.5
Macrotyloma uniflorum (Lam.) Verdc.	Kollu	1.5
Mucuna pruriens (L.) DC.	Waduru Mae	1.5
Vigna marina (Burm.) Merr.	Lea Maa	1.5
Colocasia esculenta (L.) Schott	Kalu Ala	1.8
Plectranthus rotundifolius (Poir.) Spreng.	Innala	1.8
Acrostichum aureum L.	Karam koku	2.0
Talinum paniculatum (Jacq.) Gaertn.	Gas-niwithiya	2.1
Canna indica L.	Buthsarana	2.5
Artocarpus altilis (Parkinson) Fosberg	Del	2.7
Bauhinia racemosa Lam.	Maila	2.7
Canthium coromandelicum (Burm.f.) Alston	Kara	3.0

Attitudes of the respondents toward underutilized vegetables

Attitudes reflects the behavioral intention of people in general (Ajzen 1991). Understanding the attitudes of rural women towards UVs is important to understand the behavior of women on UVs, and the reasons for their behavior and/or the practices. Table 4 summarizes the response of the respondents to the attitudinal statements. Understanding the attitudes of rural women toward UVs is important in planning and implementation measures on utilization and conservation in the future.

Attitudes of respondents (Table 4) varied from ‘strongly agree to ‘strongly disagree’ for the given statements. Many traditional vegetables and underutilized legume crops are an essential source of vitamins, micronutrients and thus, important for nutritional security (Ebert 2014). It is important that, the majority (93%) of the respondents of the present study had positive attitudes toward the health benefit of UVs, compared to commonly available vegetable species. They especially valued UVs as agrochemical-free sources of vegetables as they are freely available in-home gardens, roadsides, lowlands (paddy fields), and common lands, but not from commercial cultivations. Furthermore, the majority of the respondents (81%) ‘strongly agreed’ (35%) and ‘agreed’ (46%), that the lack of availability of UVs is one of the reasons for less consumption/utilization. Therefore, measures should be taken to cultivate and conserve those less

available UVs. However, 70% of the respondents 'agreed' or 'strongly agreed' that the consumption of UVs is less due to a lack of awareness and knowledge. Women cannot prepare UVs for consumption if they are not knowledgeable on edible UV species and their preparation. More than half of the women (58%) believed that consumption of UVs is less due to less awareness and knowledge on preparations. Especially younger generations should be made aware on how to prepare/cook UVs for consumption. The authors Singh and Verma (2015) of a similar kind of research on underutilized leafy vegetables suggest to conduct cooking demonstrations incorporating traditional recipes for rural women to popularize UVs. Their study also revealed that the young household women are less aware of UVs as well as the methods of their preparations, depicting the need for community awareness.

About 43% of the respondents 'strongly agreed' and 31% 'agreed' that the younger generation is not interested in consumption of UVs. According to the respondents, the younger generation prefer to consume curries made out of pulses (mainly *dhal*), potato, and soy meat with rice but not even the commonly available commercially cultivated vegetables. Further, the younger generation, dislikes UVs as a food source. This may be due to the rapidly changing lifestyles of the younger generation even in rural areas, where the small-scale fast-food restaurants are emerging. The present generation mostly preferred to consume instant and wheat-based food instead of the traditional staple food of rice with curries. Therefore, the changing food culture is one of the main reasons for lower consumption of UVs. Hence, there is a necessity to attract the younger generation to consume vegetables, including UVs. Novel approaches are needed to communicate the relevant messages on UVs to attract the younger generation. For instance, the 'cassava song' is a protest against the import of the staple crop rice and a plea to remain with the traditional African neglected crops especially with a view to attracting more young consumers (Baldermann *et al*. 2016). Digital social media can also be increasingly used for this purpose.

Table 4: Attitudes of the respondents toward underutilized vegetable crops

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
	(%)				
Consumption of underutilized vegetables is less due to lack of availability	35	46	5	11	3
Underutilized vegetables have more health benefits compared to commonly available cultivated crops	66	27	4	3	0
Consumption of underutilized vegetables is less due to lack of awareness and knowledge	28	42	7	18	5
Consumption of underutilized vegetables is less due to lack of knowledge on preparations	15	43	11	27	4
Attention given by the authorities for underutilized vegetables is adequate	18	22	12	28	20
Social value and recognition for underutilized vegetables affect its consumption	15	48	15	17	5
Underutilized vegetables should be conserved	60	32	5	2	1
Younger generation is not interested in consumption of underutilized vegetables compared to commonly available vegetables	43	31	13	12	1

Inadequate recognition given by the society on these UVs has also affected their human consumption, compared to other common vegetables. Underutilized species constitute a category defined by their social value and status (Padulosi *et al*. 2002). About 63% of the respondents of the present study agreed that the social value and recognition of UVs affects its consumption. Some respondents considered these UVs as a poor man's source of food. On the other hand, most of the UVs are available in common lands, road sides, paddy fields, abandoned lands like places. Meal analysis of a study conducted in Sri Lanka by Bandula *et al*. (2016) revealed that a considerable amount of underutilized crops consumed at household level were own production or wild collection. According to the discussions with the respondents of the present study, some villagers were hesitated to collect them from common lands, paddy fields or road sides, concerning their social status and recognition. Therefore, the programs should be planned to increase the social value and recognition of UVs to gain maximum out of the beneficial properties of such food crops.

Forty-eight percent of the respondents disagreed with the statement of 'attention given by the authorities for underutilized vegetables is adequate' while 40% agreed. However, research and breeding of underutilized fruit and vegetable crops are clearly underfunded when compared with main staple crops (Ebert 2014). According to a related study conducted in Sri Lanka by Malkanthi (2017), farmers were willing to cultivate underutilized crops for sale if they can have necessary facilities and a good market. In the present study, majority of the respondents (68%) 'Strongly agreed' (24%) and 'agreed' (44%) that UVs have immense potential to develop as economically important crops.

According to these findings, mainstreaming biodiversity conservation and their sustainable use for improved human nutrition & well-being is of paramount importance. Biodiversity for Food and Nutrition (BFN) project currently implemented by the Department of Agriculture in Sri Lanka is an important activity. However, in general, the government and other funding agencies give less priority to UVs in research, development and extension due to less demand and less economic value as at present, compared to common horticultural crops. This would lead to absence of improved varieties, aggravated agronomic constraints, weak marketing channels, inadequate research on value addition, and poor recognition in both rural and urban communities. These would in turn influence the extent of cultivation, availability, and consumption of UVs, which requires urgent attention of the relevant authorities.

Practices of respondents toward UVs

Women's empowerment, mainly in rural areas, is considered vital for improving household's nutritional security as women are critical pillars of food systems (Rivera & Alvarez 2017). Nevertheless, practices of rural women towards the livelihood generation and provisioning of food and nutritional security have mainly remained underexplored. Therefore, understanding the complexities connected with food security in the rural household is incomplete without a pre-understanding of women in food-related practices, UVs in particular. Men and women have different responsibilities within the family. Thus, a focus on women in relation to practices of UVs also becomes essential for this research.

While both male and female positively contribute to agricultural production (Balogun *et al*. 2014), they have specific roles in contributing to household in most farming societies. In these agricultural societies, where men are considered the main income earners, most of the work of women is seasonal and viewed as supporting role to men (Wandel & Holmboe-Ottesen 1988). However, women are highly concerned about the nutritional level, health of the family and earning extra income for the family. Their role is not only an agricultural food producer but also other food-related practices in the household, especially culinary tradition in traditional agricultural setups (i.e., food processing, preparation, preservation, deciding what to eat, and collect or bring foods to the household). They are often the household members with the knowledge to conserve, to process, and to prepare food (Accati 1984, Dukpa 2013, Rivera & Alvarez 2017). Therefore, women's contribution to the food supply is often quite considerable and is not only important for the total food supply of the household, but also for dietary variation (Haq 2004, Safilios 1981). Additionally, the role of women could be placed as an herbalist, gardener, and in the production and marketing activities. Hence, the role of women on UVs should be recognized along with the household food supply activities.

Usually, the cultivation of cash crops and other heavy work such as land preparation, protection of farmlands from wild animals, watering and other management practices are carried out by men. Female farmers are especially engaged in other important agricultural practices such as planting, weeding, harvesting, threshing, winnowing and storage and processing such as grading and grinding in addition to the food preparation at home (Adhikari 2012, Dukpa 2013, Fakoya *et al*. 2006, Haq 2004,

Malkanthi 2016). Oyugi *et al*. (2015) reported that gender is a critical factor that influences the participation of male and female farmers in utilization and conservation of UVs. The level of involvement of farmers by gender in these activities was extremely significant with female farmers exhibiting higher participation than males in cultivation of UVs (Dansi *et al*. 2012, Malkanthi 2016). This could possibly be attributed to males being attracted to cash crops which are the main income source while women continue with the cultivation of UVs since it plays a role in the household food security Oyugi *et al*. (2015).

Homestead gardening is mainly practiced by rural women in developing countries to improve household consumption, income, employment, and socio-economic status (Ferdous *et al*. 2016, Marsh 1998, Pritchard *et al*. 2018, Whitney *et al*. 2018), that help involving women in decision making and in developing a sustainable livelihood (Girard *et al*. 2012, Ferdous *et al*. 2016). Women particularly in the rural areas, tend to cultivate different useful crops particularly UVs in their home gardens mainly for diversifying family diet (Accati 1984, Haq 2004, Malkanthi 2016). After they finish daily work, they often tend to cultivate these crops in home gardens, look after them and use them for their household consumption it was mostly exchanged between friends and neighbours (Haq 2004). Women involved in homestead gardening increase household food production and income while enhancing the employment status of rural women which helps them contribute to decision making and could help the women empowerment in society (Akter 2021).

Who decides on meal preparation in the household?

In terms of family nutrition and food supply, decision-making power of women is a very important factor. Usually, women in rural households frequently supplement with wild foods such as green leaves, fruits and others. In rural areas of most developing countries, particularly in Sub−Saharan Africa and Asia, the daily activities of women are largely focused on engaging with the food chain and supply food to the entire household (Okeyo 1985).

Results of the present study indicate that 55% of the women had the freedom and sole responsibility in deciding on what to prepare for each meal for their families (Figure 3). However, 21% of the women prepare meals according to the preference of the household head and 11% as a collective decision of the husband and wife, while 21% as a collective decision of the family. Only 4% of women prepared meals according to the choice of the children. However, it was revealed that women tend not to select UVs for meals due to less preference of young children. Although the family members are involved in deciding on what to prepare for meals, all the responded women (100%) were responsible for preparing the meal. Therefore, importance of gender-sensitive projects and programs in popularizing and conservation of UVs is highlighted as women are the key-decision makers of the family meal. However, it is important to educate the children at school level to increase their interest on consumption of UVs.

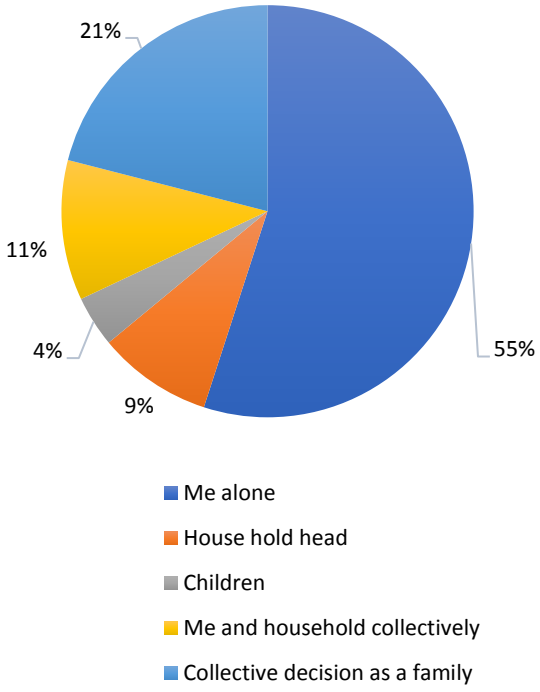

Figure 3. Respondents' percentage for decision making on what to prepare for meals

Who procures underutilized vegetables for the household?

Supplying vegetables to the household is one of the important activities in the household food chain that contributes to the food consumption and dilatory variation in the family. It is likely to change with the member in the family who ensures the food supply to the household. It is important to identify the members of the family who control the various channels, as any changes will have to be affected through those persons (See: Lewin 1943). Therefore, the person of the family bringing UVs to the house was investigated. Though the majority of women decide on what to prepare for meals, bringing in vegetables to home plays a vital role in the family.

The women in the house (respondent), household head, children, and any other person in the family were given as the options to rank in accordance with mostly bring to the least. Rank 1 was given to the person who brings most and 4 was given to the least. Figure 4 illustrates the percentage rank of each member of the household in collecting and/or bringing UVs to the household. Results reveled that women mostly collect (70%) and bring UVs to the household. The household head is the second main collector (30%) of UVs while only 6% of the households had children engaged in collecting or supplying UVs to the household.

Sometimes, women are busy with child care and other household works and the men/husband or even elderly children collect or supply vegetables to the household. Although women would advise them on the requirement for the household, the procurement decision could change at the shop/market based on what is available and the price of such products.

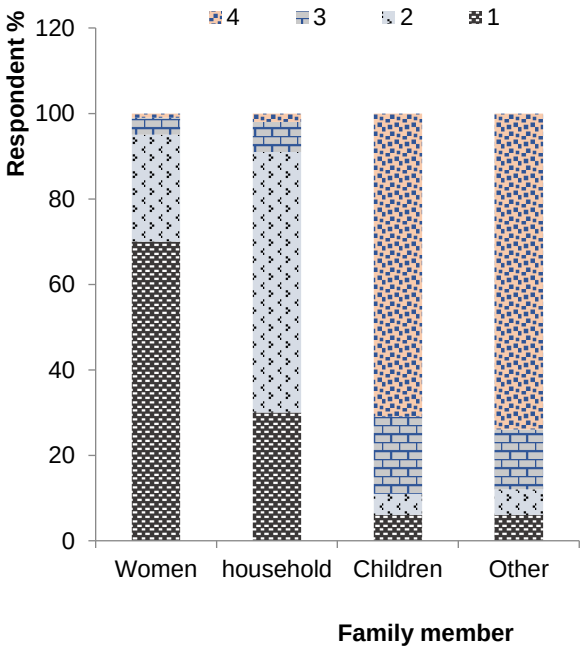

Figure 4: Gatekeepers who procure underutilized vegetables for family consumption

Sometimes, UVs that remain after family consumption or/and freely available in common lands are used to earn an extra income for the household. Thus, gender role in the marketing of the neglected and underutilized crops of family members and their earning capacity of extra income by selling excess production should be recognized well and valued correctly. Female farmers contribute more significantly to the marketing of the UVs than their male counterparts (Adhikari 2012, Dansi *et al*. 2012, Dukpa 2013). However, it also reported that they are not able to determine price according to supply and demand and, they are in a weak position when it comes to negotiating price (Haq 2004). This could be because they tend to sell their crops at irregular intervals to meet secondary expenses.

According to the present study, many women in households have earned marginal income themselves from sales of products such as leafy vegetables, fruits, and others by selling those to the vendors who in turn market the products in village boutiques, intermediaries, or to the economic centers. The present study revealed that 43% of households earned extra income by selling UVs and 37% of them sold the UVs to the nearby dedicated economic center (i.e., Dambulla in the central province of Sri Lanka). Therefore, external support to improve the rural livelihoods through income security, improving the cultivation and providing marketing facilities are important. '*Wayamba isuru'* direct market of the rural ecological producers in Kurunegala district of Sri Lanka (Hansika & Wijerathna 2021) is one good intervention to promote organic UVs while empowering rural people especially the women.

Medicinal properties

Many respondents believed in medicinal properties of UVs. People recognize the role played by traditional medicine in rural healthcare, as it saves the health expenses of the poor households. In the developing countries, around 80% of the populations depend on the traditional medicine derived from plants (Cunningham 1993, Misra *et al*. 2008). The UVs have been a source of traditional medicine since time and immemorial and contributed to people's health in many ways. As an alternative for western medicine, rural people habitually use some UVs as a home-based treatment for simple health disorders since these remedies are readily accessible in the form of food (Jena *et al.* 2018, Joshi & Chaturvedi 2013).

UVs are rich sources of minerals, vitamins and other health promoting substances including high antioxidant activity such as phytochemicals (i.e., polyphenols, ascorbic acid, and carotenoids to varying degrees (Andarwulan *et al*. 2012, Jena *et al.* 2018). The availability and variety of these components regulate the functionality of these vegetables that helps to prevent deficiencies or diseases, and health promotion. Though it has not been tested, underutilized crops and their food serves as best sources of micronutrients and other health promoting factors for the human body, many

nutrients from common vegetables have been characterized and quantified (Andarwulan *et al*. 2012). However, similar analysis of UVs from Sri Lanka is lacking.

Depending on the species, and plant parts such as seeds, leaves, roots, and even barks are used to treat many chronic and general ailments (Aregheore *et al*.1998, Attanayake & Jayatilaka 2016, Kadiri & Olawoye 2016). Furthermore, regularly adding these vegetables to diets is associated with reduced risks of cardiovascular disease, inflammatory bowel diseases, and some cancers (Amre *et al*. 2007, Dauchet *et al*. 2010, Jain *et al*. 1999). Finally, such plants are also used in ophthalmology, and to treat hydrophobia, fractures, snake poisoning, and bums (Weragoda 1980).

Although rural people are well aware of the nutritional and medicinal properties of the UVs and consume as a part of their regular diet, such information is unknown to city dwellers. Nevertheless, at times, these vegetables form part of diet of low-income urban people adding nutrients and other health benefits for their well-being (Jena *et al.* 2018). Some underutilized crops are often used as a home-based treatment for simple health disorders and in ayurvedic treatment centers in rural areas. The city dwellers also often visit those places located in rural areas for treatments. Thus, the demand for these plants is continuously increasing day by day resulting due to lesser side effects in comparison to synthetic drugs (Joshi & Chaturvedi 2013). Unfortunately, in the present day, rapid economic development and suburbanization resulted in overuse and loss of valuable natural resources, including the medicinally important plants. As a result, many of the plant species are endangered or threatened with extinction (Arora & Bhojwani 1989, Sudha & Seeni, 1994).

Characterizing the distribution useful components of these UVs can inform dietary and horticultural efforts to rise the consumption of these potentially beneficial components. Future studies are required to investigate the efficacy and reasonable mechanisms for the medicinal uses of these UVs. Table 5 presents vegetables with special medicinal properties that can be used to treat several diseases, as identified by the respondents of the present study

Table 5: Medicinal properties of selected UVs as stated by the respondents (better seek advice from a professional before using a plant medicinally)

Species	**Health benefits**
Coccinia grandis (L.) Voigt	Commonly used by villages for lowering of blood sugar (diabetes)
Lasia spinosa (L.) Thwaites	Treatment for haemorrhoids, clean the intestine, and diabetes
Kalanchoe pinnata (Lam.) Pers.	Cure the diarrhoea, poisonous insect bites and burning injuries
Canna indica L.	Treatment for amenorrhoea, promote urination
Erythrina variegata L.	Used to treat the inflammation and paints in joints
Portulaca oleracea L.	Well known treatment for burning injuries, strangury and sores
Hygrophila auriculata (Schumach.) Heine	Used to strengthen the genital system and protect the liver
Bacopa monnieri (L.) Wettst.	Treatment for indigestion, constipation, asthma, bronchitis and infertility
Sauropus androgynus (L.) Merr.	Used to cure coughs, and used as an energiser
Diplazium esculentum (Retz.) Sw.	Treat spots, scars, tumours, and asthma
Cycas nathorstii J. Schust	Treatment for vomiting, facilitate the gas passing in the intestine

Common ways of preparation of UVs

The survey identified that the village women have inherent ability to prepare underutilized vegetables using their own recipes. Furthermore, it was identified that they prepare underutilized vegetables basically in the form of a *mallum,* salad, curry, *ambula,* and porridge as shown by the figure 5.

Mallum:

When the scraped coconut is added to a cooking vegetable, the mixture is generally known as a *mallum* in the local language. Green leaves 100g, 3-4 green chilly sliced, 1/2 onion sliced, ½ cup fresh scraped coconut, 1/4 teaspoon (tsp) turmeric, salt as per taste, and few drops of cooking oil are needed as the ingredients for this recipe.

First, fresh leaves are cleaned, drained, and scraped cut into fine slices. Onion and green chilly are sliced into small pieces. They are mixed well with scraped coconut, and salt is added to taste. Few drops of coconut oil are added to a pan and heated and mixed well. However, the use of coconut oil is optional. It is cooked under low heat for 2-3 minutes and should not be overcooked. Some Underutilized leafy vegetables used in the studied area to prepare *mallum* are *Polyscias fruticosa* (L.) Harms (*koppa kola*), *Cheilocostus speciosus* (J.Koenig) C.D.Specht (*thebu*), *Coccinia grandis* (L.) Voigt (*kowakka*), *Premna procumbens* Moon (*lee kola pala*), *Canthium coromandelicum* (Burm.f.) Alston (*kara kola*).

Not only the leafy vegetables, but also some other vegetables like *Artocarpus altilis* Burm.f.) Alston (*breadfruit*), *Solanum violaceum* Ortega (*titta-tibbatu*), Banana blossom (*Musa* spp.) and *Lasia spinosa* (*kohila*) are prepared as *mallum* with some slight variations in preparation and ingredients used. A mixture of unroasted and grounded spices including coriander, cumin seeds, and fennel seeds are used in this preparation. First, the vegetables are cooked with a small amount of water, salt, and saffron powder. Then, the unroasted spice mixture and scraped coconut are added with other ingredients like green chilli, garlic, pepper, curry leaves, and cook for 3-5 minutes. It is optional to add 1-2 tablespoon of coconut oil into a separate pan and add ¼ tablespoon of mustard and then other ingredients like chopped garlic, onion, green chilli, curry leaves, and pandan leaves and allowed to fry until garlic and onion turn brownish. Finally, the cooked vegetable is added into the pan and tempered for 2-3 minutes. However, adding coconut oil is optional. Also, a traditional stone grinder or mortar and pestle are used to grind the green chilli and garlic and raw cumin seeds, coriander and fennel seeds first and then mixed (slightly ground) with scraped coconut before adding to the cooked vegetables with water, salt, and saffron. The characteristic taste of the vegetables can only be obtained by cooking in this way. However, the modern way of cooking avoiding this traditional method with no more use of mortar and pestle and the stone grinder and also due to the time limitation with the busy life styles. Moreover, some women used unroasted readily available mix of spices instead of the mixture of freshly ground raw spices.

Saladlsambal:

Salad or *sambal* in the local language is the fresh form of preparations usually consumed as a side dish of cooked rice. Only some UVs such as *Lasia spinosa* (*kohila*), *Dregea volubilis* (L.fil.) Benth. (*anguna*), *Momordica denudata* (thwaites) C.B.Clarke (*batu karawila*) etc. are used to prepare this kind of salad dishes.

Ingredients for 3-4 servings are a handful of leaves, ½ cup fresh grated coconut, 3-4 small red onion/shallots sliced, 2-3 green chilly sliced, a pinch of pepper, salt to taste and 1 tea spoon of lime juice and Maldives fish (optional).

Leaves are washed and allowed to drain water and then sliced into the thin pieces. Freshly grated coconut, sliced onion, sliced green chili, pepper, and salt are mixed together with lime juice in a separate bowl. The taste is checked at this time and adjust salt and lime if necessary and lastly, add sliced leaves and mixed gently just before to serve to keep the freshness.

***Curry*:**

Curry is the most common type of preparation of UVs to be consumed as a side dish with the starchy staple (i.e., cooked rice). Usually, a curry contains a sizable portion of the source (gravy). This is basically done by adding coconut milk.

Ingredient**:** Vegetables, chili powder, turmeric powder, curry powder (A mix of chilli, pepper, coriander, funnel seed), cinnamon, cardamom, cloves, fenugreek, garlic, curry leaves, pandan leaves, salt, green chili, and onion.

The vegetables are washed (sometimes peeled) and sliced. Then a small amount of above-mentioned spices each is added to flavor the curry and mixed. Coconut milk is added to maintain the thickness of the gravy. Heat the saucepan over medium-high heat, while stirring occasionally, until the coconut milk/water comes to the boiling point. Then reduce the heat to a simmer, and let it cook under cover for about 5 minutes. Uncover and cook for a further 5 - 10 minutes under low flame while stirring frequently. The cooking time will vary depending on the vegetable. If the liquid is evaporating too quickly, more water or coconut milk could be added. At this stage, the taste is checked and adjusted by adding salt if necessary. Some examples for UVs that fall under curry option are, *Artocarpus altilis* (*del*), *Acrostichum aureum* L. (*karan koku*), *Lagenaria siceraria* (Molina) Standl. (*labu*), *Ipomoea littoralis* (L.) Blume (*thel kola*), *Trianthema portulacastrum* L. (*sarana*), *Lasia spinosa* (*kohila*), *Moringa oleifera* Lam. (*murunga*), *Dieoscoria* spp., and others.

Ambula:

Vegetables prepared with some sour ingredients like garcinia (*Garcinia quaesita* Pierre) and tamarind (*Tamarindus indica* L.) are usually known as *ambula*

(sour taste) in local language. Chilli powder and a mixture of coriander (*koththamalli*), cumin seeds (*suduru*) and fennel seeds (*mahaduru*) are used as the main spices. In this preparation, one other specialty is the spices are usually roasted to enhance the flavor before adding. Spices like cardamom, cloves and coconut milk are added and allowed to cook under the slow flame for a long time depending on the type of vegetable, compared to a curry. Some examples are *Ipomoea littoralis* (*thel kola*), *Canthium coromandelicum* (*kara-kola*), *Celosa argentea* L. (*kiri-handa*), and immature leaves of some Dioscoreaceae species.

Porridge

Porridge is a traditional herbal drink usually used for breakfast. Due to its high medicinal and nutritional values, it is much popular among Sri Lankans at present. Usually leaves of some herbal plants are used to prepare porridge such as *Asparagus falcatus* L. (*hathawariya*), *Senna auriculata* (L.) Roxb. (*ranawara*), *Hemidesmus indicus* (L.) R.Br. (*iramusu*).

Ingredients**:** long-grain white or red rice (unstemmed), extraction of leaves, coconut milk, water, fenugreek, salt, garlic, pepper, ginger.

First, the rice is washed well and allowed to drain. Then it is cooked well by adding water, pepper, ginger, fenugreek, salt, and garlic. Let it boil well on medium/low heat with lids on. Until the rice starts boiling, the time can be effectively used to extract herbal juice from the selected leaves. The leaves must be properly cleaned and washed before crushing (i.e., by grinding) along with the scraped coconut. Once properly crushed (ground), the green leaf and coconut mixture is mixed with an adequate volume of water and squeezed to obtain the greenish leaf extract. The herbal extract is set aside for later use. The stage of adequate cooking of rice can be made sure by pinching a grain by finger. Then the herbal extract is added to the cooked rice bowl and kept under medium/low flame for a short while for proper absorption of the green juice into rice grains. Then the rice will become sticky, forming the characteristic texture of the porridge. The porridge must not be overcooked. At this stage, it is advisable to adjust the taste by adding salt. When it starts to bubble it is done.

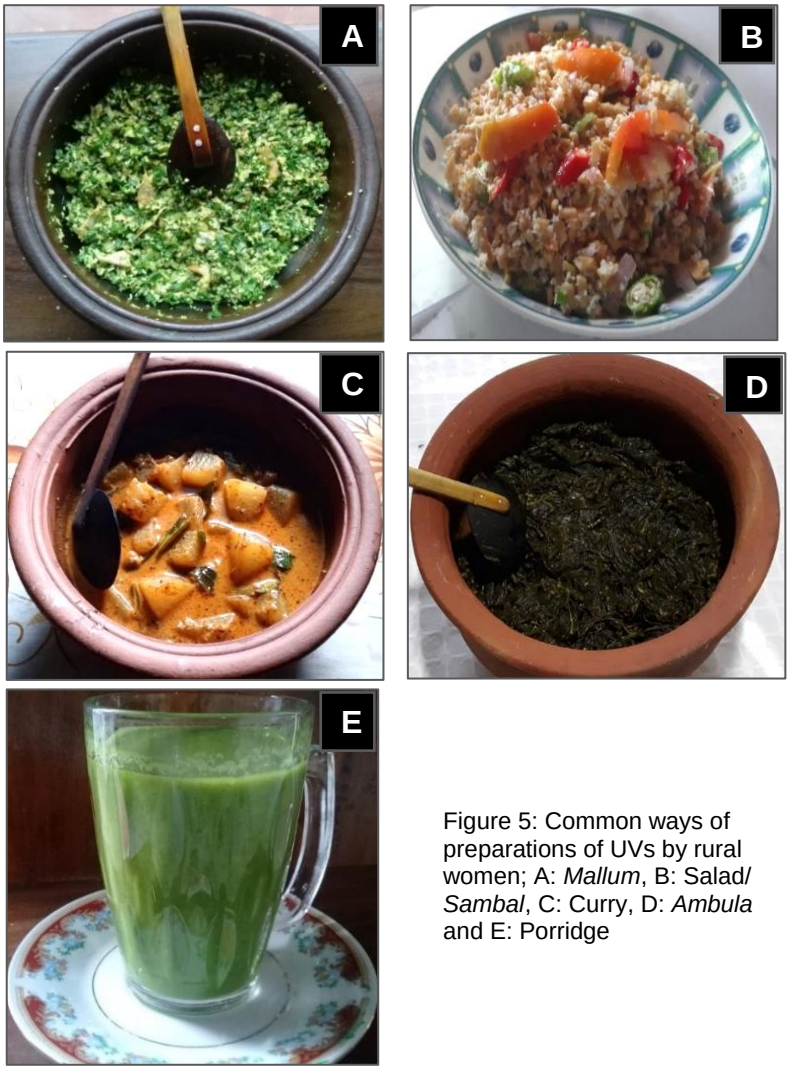

Figure 5: Common ways of preparations of UVs by rural women; A: *Mallum*, B: Salad/ *Sambal*, C: Curry, D: *Ambula* and E: Porridge

Role of Women in UVs conservation

With the introduction of high yielding cultivation packages in commercial agriculture, the species diversity of vegetables has been minimized allowing a limited number of crops dominating as at present, the process has led to a severe genetic erosion and dilution of their gene pool of vegetables (Williams & Haq 2002). Furthermore, UVs-associated indigenous knowledge is facing extinction due to the changes in the physical environment, increasing population pressure, and rapid development of socio-economic status and changing life styles (Abeywardana *et al*. 2019). It is now clear that efforts to conserve biodiversity and preserve traditional food systems and farming practices need to be combined and enhanced (Aregay *et al*. 2017). Hence, the conservation of UVs and associated knowledge is of paramount important as it has great potential to be incorporated with modern agricultural knowledge for enhancing crop productivity. In this context, rural women play a crucial role and their contribution is also significant for the popularizing of UVs. Although women play a key role in cultivation and conservation of UVs in homestead and farmlands, it has not been properly explored and documented their role in the conservation of UVs. The findings of the present study clearly depict the role of rural women and their importance as an, excellent source of information about UVs.

Women have been the custodian of plant genetic resources and its related indigenous traditional knowledge from time immemorial (Sood *et al*. 2015). It necessitates the women, particularly at their young ages, to acquire more traditional knowledge for perform well in their domestic tasks. Howard (2003) defined the domestic roles as collectors and food processors, herbalists, informal plant breeders, gardeners, and post-harvest technologists (for preservation) of plant species that have medicinal, fuel, and fiber values. Owing to their crucial role within the family as well as rural society, it is essential to use the engagement in conservation and popularizing UVs in the community (Byers & Sainju 1994). Home gardens play a vital role in *in-situ* conservation of biodiversity where women have the knowledge, skill, and everyday jobs. Usually, women collect the seeds or planting material of these plants and store or cultivate them in their home gardens to help conservation by conserving them against extinction while getting benefits from them. Also, the role of women in agriculture production varies from managers of small farm holdings to landless labourers, thereby contributing equally to the household income. Not only this, they are the vigilant guards and custodians of our traditional culture, rituals or festivals thereby playing a pivotal role in maintaining and conserving the cultural plant diversity (Sood *et al*. 2015). Moreover, Montanari and Bergh (2019) revealed that women's traditional knowledge is readily integrated in the development of natural products, vital in product development yet is not officially acknowledged by the employers and national legislation.

Constrains in popularizing and cultivation of UVs

Domestication and utilization of underutilized crop species have been driven by several challenges. One of the major limitations to the development and widespread cultivation of underutilized vegetables is the lack of available knowledge on their potential to contribute to sustainable food production and food security. Not only that, people do not have an adequate understanding of their unique and rich medicinal and nutritional properties. Rai *et al*. (2004) clearly stated that lack of awareness among the farming community about the nutritional and medicinal value of underutilized horticultural crops as one of the main constrains in popularizing of UVs. Inadequate research and extension services keep it away from the cultivation. Most of the research funds have always been dispatched on further improvements of major crops-based cropping systems, elevating their positions against the competition with the traditional crops. Malkanthi (2017) has also identified the same challenges in popularizing UVs while studying the importance of underutilized crops in Thanamalwila divisional secretariat division in Monaragala district in Sri Lanka. Not only Asia, but most of the other African countries also face similar challenges in popularizing underutilized crops, particularly vegetable crops (Aregay *et al*. 2017, Baldermann *et al*. 2016, Mabhaudhi *et al*. 2017).

Inadequate availability of quality planting materials is also a major constraint as the seeds/planting materials production of these crops is limited to few parties which are supposed to have a breakeven. Usually, seeds and other edible parts are difficult to collect even from the available plants and normally some take a long time for physiologically mature. Knowledge on the yield estimates and the details of their agronomic requirements are also scare, leading to weak guidance on cultivation, which is a major impediment to popularize UVs among farmers. Apart from that, we agree with Padulosi *et al.* (2013) argument that to improve the utilization of such neglected plants they have to be characterized with respect to their properties, cultivation requirements, and processing applicability.

The poor recognition of UVs in horticulture promotion programs is one of the major impediments to popularize such crops in large scale cultivation (Jena *et al*. 2018). Our findings also revealed that only a small segment of the society has recognized the role of these crops and negative attitudes of others

especially in the younger generation on the UVs have affected negatively on their popularizing campaigns. There is no adequate information available on value-addition and new recipes to match with the modern culinary practices. Moreover, we identified that inadequate land availability for cultivation in farmlands commercially, and other spaces in reservoir bunds, channels, and roadsides has also affected expansion of cultivation of UVs. A substantial initial funding by the international donor community and national state programs is necessary to achieve this goal and to generate interest among private sector breeders once significant market potential is within reach (Ebert *et al*. 2014). Overexploitation of naturally available UVs without conservation can also be found especially in areas having local treatment centers where these plants become more valuable. Also, the transformation of land usage, such as forest to agriculture and agriculture to housing, to accommodate increasing populations has led to changes in natural habitat and biodiversity loss, reducing the availability of wild neglected underutilized species and the suitability of cultivated underutilized species (Raneri *et al*. 2019).

Recommendations to popularize and conserve UVs

Recommendations for popularizing and conserving UVs have been discussed in detail by various authors (Aregay *et al*. 2017; Jena *et al*. 2018; Mabhaudhi *et al*. 2017). As Baldermann *et al*. (2016) suggested, to exploit the potential of such neglected species, coordinated approaches on the local, regional, and international level have to be integrated that consequently demand the involvement of numerous multi-stakeholders. They further mentioned that to develop strategies for the promotion of neglected plant species, barriers against mainstreaming these plants have to be first identified and then analyzed (Baldermann *et al*. 2016).

To maximize the popularity of UVs, following strategies are proposed based on findings of the current study. These include (a) domestication of potential wild species through homestead cultivation should be encouraged, (b) introducing a national-level programs to improve reputation of these crops especially within the new generation, (c) National and institutional policy support are required to develop the seed industry and to device appropriate marketing channels. Also, policy support is required for undertaking research and developments on the multiplication (planting material production) of UV species, (d) Adaptation of standard breeding programs may help to address some of the current issues such as low yield, harvesting difficulties, and others aiming more market access. (d) Timely inputs supply and motivating farmers to grow these crops through developmental initiatives would enhance the food and income security of the local community. (e) Identification of suitable crops with exceptional traits that match with the market or end-user potential should be a priority. (f) The research needs to be geared up on crops that fit in well with different farming systems to explore their potential to be commodity crops. (g) Improving consumer awareness on the value of underutilized vegetables together with proper extension and awareness programs to improve farmers' knowledge and skills on the farming/cultivation aspects of the UVs should be developed.

Conclusions

Considerable diversity of UVs exists in the four studied villages. However, the consumption of some UVs was found to be at a minimum level due to various reasons. Therefore, special attention should be given to popularize them among farmers and consumers while documenting associated knowledge of UVs is essential before disappearing the old generations of local communities. The interest and consumption of UVs by the young generation was considerably low compared to the elders. Therefore, measures should be taken to improve their interest and thus the rate of consumption. At present, women are not having the skills to prepare those vegetables as they used to have in the past. Educational programs on UVs for school children and cooking demonstrations are useful in this regard. Some UVs are freely available in common lands but people are reluctant to collect those UVs due to less social value and recognition on those species. Therefore, some programs should be planned to increase the social value and recognition regarding UVs.

Due to the lack of demand and low prices in the market, UVs are not generally being cultivated by rural farmers in the studied area. Most of the farmers have general knowledge about the importance of underutilized crops. The main goals of the cultivation of underutilized crops are to fulfil the food requirement of the family. If necessary, actions are taken to multiply the underutilized vegetables, they will be able to find an extra income for the family. At present, most of the families use UVs as herbals for simple health disorders of family members and neighbors to recover illnesses, to cure injuries, snake bites, and other accidents. The study revealed that in the past, these crops were freely available in common lands as well as grown in almost all home gardens. Owing to that, these respondents also have a sufficient level of knowledge about the cultivation and management of these crops.

It is noted that the farmers are still willing to cultivate these crops for commercial purpose if they can have adequate facilities including marketing channels. Therefore, it is important to make arrangements to develop and popularize these crops among the people while creating new market opportunities. Providing necessary inputs, storage, and processing facilities will help them to keep on growing these crops on their farms fostering sustainable use and conservation, enhancing the food security and livelihood of the rural as well as urban communities.

Declarations

List of abbreviations

KAP: Knowledge, Attitude and Practices
UVs: Underutilized Vegetables
UNSDG: Nations Sustainable Development Goals
MDP: Mahaweli Development Project
BFN: Biodiversity for Food and Nutrition
IK: Indigenous Knowledge
RBE: Reddish Brown Earth
LHG: Low Humic Gley
GCE: General Certificate of Education
A/L: Advanced Level
O/L: Ordinary Level

Ethics approval and consent to participate:

Before conducting interviews, prior informed permission was obtained from all participants. No further ethics approval was required.

Consent for publication:

This paper does not include any individual person´s data and further permission for publication is not required.

Availability of data and materials:

The data was not deposited in public sources.

Conflict of interests:

The authors declare that they have no competing interests.

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Authors' contribution

This work was carried out in collaboration between all four authors. All authors contributed to the research proposing the problem, data collection, and read and accepted the final manuscript. Authors, Madhavi Wijerathna and Ranil Rajapaksha designed the study, wrote the protocol and improved the first draft written by other two authors. Author Ruwan Chamara and Ishani Herath performed and managed the statistical analysis, wrote the first draft of the manuscript, and managed the literature searches.

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Appendix 01. The list of underutilized vegetable species recorded in surveyed area

Family	Botanical name	Sinhala name	Species status	Edible part
1. **Acanthaceae**	*Hygrophila auriculata* (Schumach.) Heine	Ikiriya	Native	L
2. **Aizoaceae**	*Trianthema portulacastrum* L.	Sarana	Native	L
3. **Amaranthaceae**	*Achyranthes aspera* L.	Karal-sabo	Native	L
4. **Amaranthaceae**	*Aerva lanata* (L.) Juss. ex Schult.	Pol-pala	Native	L, R, S
5. **Amaranthaceae**	*Amaranthus spinosus* L.	Katu-tampala	Native	L, S, F
6. **Amaranthaceae**	*Celosa argentea* L.	Kiri-handa	Native	L
7. **Annonaceae**	*Polyalthia korinti* (Dunal) Thwaites	Ul-kenda	Native	F
8. **Apocynaceae**	*Dregea volubilis* (L.f.) Benth. ex Hook.f.	Anguna	Native	L, F, R
9. **Apocynaceae**	*Gymnema lactiferum* (L.) R. Br. ex Schult.	Kurinnan	Native	L
10. **Apocynaceae**	*Tylophora* sp.	Kiri-anguna	Native	L, F
11. **Aponogetonaceae**	*Aponogeton natans* (L.) Engl. & K. Krause	Kekatiya	Native	L, S, R
12. **Araceae**	*Alocasia* sp.	Kalu-ala-kola	Cultivated	L, R
13. **Araceae**	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Kidaran	Native	R
14. **Araceae**	*Colocasia esculenta* (L.) Schott	Kalu ala	Native	R
15. **Araceae**	*Lasia spinosa* (L.) Thwaites	Kohila	Native	L, F, RH
16. **Araceae**	*Syngonium angustatum* Schott	Wel-kohila	Naturalized	L, F
17. **Araliaceae**	*Polyscias fruticosa* (L.) Harms	Koppa kola	Cultivated	L
18. **Asparagaceae**	*Asparagus falcatus* L.	Hatawariya	Native	L
19. **Asteraceae**	*Cyanthillium cinereum* (L.) H.Rob.	Monara-kudumbiya	Native	L
20. **Asteraceae**	*Eclipta prostrata* (L.) L.	Kikirindi	Native	L
21. **Athyriaceae**	*Diplazium esculentum* (Retz.) Sw.	Miyena-dalu	Native	L
22. **Boraginaceae**	*Carmona retusa* (Vahl) Masamune	Heentampala	Native	L
23. **Boraginaceae**	*Cordia dichotoma* G.Forst.	Lolu	Native	L, F, R, S
24. **Cannaceae**	*Canna indica* L.	Butsarana	Naturalized	L, R, S
25. **Commelinaceae**	*Commelina benghalensis* L.	Diya-meneriya	Native	L
26. **Commelinaceae**	*Commelina diffusa* Burm.f.	Gira-pala	Native	L
27. **Convolvulaceae**	*Argyreia populifolia* Choisy	Giri-tilla	Endemic	R
28. **Convolvulaceae**	*Ipomoea alba* L.	Alanga	Cultivated	F
29. **Convolvulaceae**	*Ipomoea littoralis* Blume	Tel-kola	Native	L

30. **Costaceae**	*Cheilocostus speciosus* (J.König) C. Specht	Tebu	Native	L
31. **Crassulaceae**	*Kalanchoe pinnata* (Lam.) Pers.	Akkapana	Naturalized	L
32. **Cucurbitaceae**	*Benincasa hispida* (Thunb.) Cogn.	Alu-puhul	Cultivated	F
33. **Cucurbitaceae**	*Coccinia grandis* (L.) J.Voigt	Kowakka	Native	F, L
34. **Cucurbitaceae**	*Lagenaria siceraria* (Molina) Standl.	Labu	Cultivated	F
35. **Cucurbitaceae**	*Luffa cylindrica* (L.) M.Roemer	Niyan-wetakolu	Cultivated	F
36. **Cucurbitaceae**	*Momordica denudata* (Thwaites) C.B.Clarke	Batu-karavila	Native	F
37. **Cycadaceae**	*Cycas nathorstii* J. Schust.	Madu	Native	L, S
38. **Dioscoreaceae**	*Dioscorea alata* L.	Raja-ala	Cultivated	T
39. **Dioscoreaceae**	*Dioscorea bulbifera* L.	Udala	Native	T
40. **Dioscoreaceae**	*Dioscorea esculenta* (Lour.) Burkill	Kukulala	Native	T
41. **Euphorbiaceae**	*Acalypha indica* L.	Kuppamenia	Native	W
42. **Euphorbiaceae**	*Sauropus androgynus* (L.) Merr.	Malla-dum-kola	Native	L
43. **Fabaceae**	*Bauhinia racemosa* Lam.	Maila	Native	L
44. **Fabaceae**	*Bauhinia tomentosa* L.	Petan	Native	L
45. **Fabaceae**	*Canavalia ensiformis* (L.) DC.	Awara,	Cultivated	L, F
46. **Fabaceae**	*Cassia occidentalis* L.	Peni-tora	Native	L
47. **Fabaceae**	*Erythrina variegata* L.	Weta-erabodu	Native	L
48. **Fabaceae**	*Macrotyloma uniflorum* (Lam.) Verdc.	Kollu	Native	S, L
49. **Fabaceae**	*Mucuna pruriens* (L.) DC.	Wanduru-ma	Cultivated	F, L, S
50. **Fabaceae**	*Phaseolus lunatus* L.	Potu-dambala	Cultivated	F, L
51. **Fabaceae**	*Senna auriculata* (L.) Roxb.	Ranawara	Native	L
52. **Fabaceae**	*Senna tora* (L.) Roxb.	Tora	Native	L.
53. **Fabaceae**	*Vigna marina* (Burm.) Merr.	Lee-ma	Cultivated	S
54. **Lamiaceae**	*Plectranthus rotundifolius* (Poir.) Spreng.	Innala	Cultivated	R
55. **Lamiaceae**	*Premna procumbens* Moon	Le-kola-pala	Native	L
56. **Lecythidaceae**	*Careya arborea* Roxb.	Kahata	Native	F
57. **Marantaceae**	*Maranta arundinacea* L.	Hulan-kiriya	Naturalized	R
58. **Moraceae**	*Artocarpus altilis* (Parkinson) Fosberg	Del	Cultivated	F
59. **Moraceae**	*Ficus racemosa* Lam.	Attikka	Native	F, L
60. **Moringaceae**	*Moringa oleifera* Lam.	Murunga	Cultivated	L, F

61. **Nelumbonaceae**	*Nelumbo nucifera* Gaertn.	Nalum	Native	F, R, S,
62. **Nyctaginaceae**	*Boerhavia diffusa* L.	Pita-sudu-pala	Native	L
63. **Nymphaeaceae**	*Nymphaea nouchali* Burm.f.	Maneal	Native	Rh
64. **Nymphaeaceae**	*Nymphaea pubescens* Willd.	Et-olu	Native	S
65. **Olacaceae**	*Olax zeylanica* L.	Mella	Native	L
66. **Oxalidaceae**	*Averrhor bilimbi* L.	Billing	Cultivated	F
67. **Periplocaceae**	*Hemidesmus indicus* (L.) R.Br.	Iramusu	Native	L
68. **Plantaginaceae**	*Bacopa monnieri* (L.) Wettst.	Lunu-wila	Native	W
69. **Phyllanthaceae**	*Antidesma alexiteria* L.	Ambilla	Native	F
70. **Pontederiaceae**	*Monochoria hastata* (L.) Solms-Laub.	Diya-habarala	Native	L
71. **Portulacaceae**	*Portulaca oleracea* L.	Genda-kola	Native	W
72. **Portulacaceae**	*Talinum paniculatum* (Jacq.) Gaertn.	Gas-niviti	Naturalized	L, S
73. **Pteridaceae**	*Acrostichum aureum* L.	Keran-koku	Native	L
74. **Rubiaceae**	*Canthium coromandelicum* (Burm. f.) Alston	Kara-kola	Native	L
75. **Rubiaceae**	*Hedyotis fruticosa* L.	Weraniya	Native	L.
76. **Sapindaceae**	*Cardiospermum halicacabum* L.	Penela-wel	Native	L
77. **Solanaceae**	*Solanum insanum* L.	Ela-batu	Native	F, L
78. **Solanaceae**	*Solanum macrocrpon* L.	Ahas-batu	Introduced	F, L
79. **Solanaceae**	*Solanum violaceum* Ortega	Titta-tibbatu	Native	F

Note: Leaf (L), Fruit (F), Stem (S), Root (R), Rhizome (Rh)