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USE, MANAGEMENT AND NUTRITIVE VALUE OF EDIBLE NON-CROP PLANTS IN AGROFORESTRY AND TRIBAL LANDSCAPES OF KERALA

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Cleome viscosa L. - Capparidaceae - നായ്ക്കടുക്

Cassia occidentalis L. - Caesalpiniaceae - പൊന്നിൻതവര

Centella asiatica (L.) Urb.
Apiaceae
മുത്തിളില

Cissus discolor Blume
Vitaceae
വള്ളിമരുമ

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ABSTRACT OF PROJECT PROPOSAL

Code	KFRI RP 603/2010
Title	Use, management and nutritive value of edible non-crop plants in agroforestry and tribal landscapes of Kerala
Objectives	a. To identity and quantify edible non-crop herbaceous and shrub species in agroforestry and tribal landscape of Kerala, and b. To evaluate the nutritional values of edible non-crop plants
Project period	July 2010 to April 2014
Funding agency	KFRI Plan Fund Grant
Scientific personnel	U.M. Chandrashekara

CONTENTS

ABSTRACT

The homegardens of Kerala are known for the high diversity of their species in both cultivated and non-cultivated (hereafter, non-crop) plant communities. The non-crop plants can be categorised into edible and non-edible plants. A study was conducted to identify edible non-crop plants in homegardens of a village located in the mid-land agroclimatic zone of the State. Among the 27 edible non-crop species identified six species namely, *Cassia occidentalis, Cassia tora, Centella asiatica, Oxalis corniculata, Phyllanthus urinaria and Portulaca oleracea* were found in more than 40 homegardens. A significant positive correlation between the number of homegardens accommodating and using the species was also noticed. 25 out of 27 species were also recorded from the plots located near a tribal hamlet and all these plants are used by the informants. In homegardens, all edible non-crop plants are managed at a minimal level by tolerance and protection. Among the species studied, *Cassia occidentalis* in homegardens and *Alternanthera sessilis*, *Boerhaavia diffusa* and *Cassia tora* in the tribal landscape were significantly rich in terms of standing aboveground biomass. Nutritionally, all the investigated edible non-crop species could contribute substantially to protein, minerals and crude fibre intake. Being rich in protein (19.3 mg g^{-1} to 54.3 mg g^{-1}), fat (0.004 mg g^{-1} to 0.016 mg g^{-1}), fibre (12.6 mg g^{-1} to 49.8 mg g^{-1}), minerals (25.7 mg g^{-1} to 58.3 mg g^{-1}),calcium (3.3 mg g^{-1} to 13.3 mg g^{-1}), phosphorous (0.3 mg g^{-1} to 3.2 mg g^{-1}) and iron (0.2 mg g^{-1} to 0.8 mg g^{-1}), these species are nutritionally comparable to or even better than several cultivated vegetables in the country. Contrary to the general fear at the global level that rural landscapes in general and homegardens in particular are losing their traditional characteristics, the present study demonstrated an example of a system in which an important traditional feature i.e. utilisation of non-crop plants is still prevailing. In the context of changing socio-economic scenario, however, efforts are required to strengthen traditional system so that they will maintain optimal combination of ecological and productive features and at the same time ensure nutritional security and plant diversity in homegardens and rural landscapes.

INTRODUCTION

It is estimated that 12,000 of the world's plants are edible (Lewington, 1990) and out them about 150 are important crops. More than ninety percent of the world's food comes from only fifteen plant species: rice, wheat, maize, sorghum, barley, sugar cane, sugar beet, potato, sweet potato, manioc, beans, soy bean, peanut, banana and coconut. Most societies today rely on agriculture for their food provision. But that does not mean that agriculture alone provides all food. Non-domesticated or non-crop plants remain important in all agricultural systems (Scoones *et al.*, 1992). They can be an essential ingredient to people's diets to provide essential vitamins and minerals. Edible non-crop plants are considered as famine and seasonal foods with high potential for income generation. Therefore, edible non-crop plants have been named the "hidden harvest" of agriculture (Scoones *et al.*, 1992).

Among different agroforestry systems prevailing in Kerala, homegardens are glorious examples of species diversity in cultivated and managed plant communities. There are nearly 3-4 millions of homegardens in Kerala, covering about 88% of the total landholding and about 41% of the total cultivable area of the State. In homegardens, nearly 30 million people reside, earn living and enjoy direct and indirect benefits of the system (KSLUB, 1995). Over 170 species were recorded from an inventory made in 128 randomly selected homegardens in the State (Sankar and Chandrashekara, 2002). Inventory of plants in the live fence alone of 60 homegardens registered 68 species (Chandrashekara *et al.*, 1997). Chandrashekara (1995) reported 60 tree species out of 124 plant species encountered in a homestead of about 1 ha in the central agroclimatic zone of the State. All these observations indicate that the homegardeners are perpetual `experimenters' and are constantly trying and testing new species (Ninez, 1987). Inventory of floristic diversity in homegardens of Kerala revealed that, in general, homegardens play a role as informal experimental stations for transfer, trial and adoption of species useful to the system (Chandrashekara and Sankar, 2008). Similarly, homegardens represent a `genetic backstop', preserving species and varieties that are not economic in field production and are planted in small scale for reasons of taste preference, tradition or availability of planting materials. An important characteristic of the homegardens of Kerala is predominance of fruit plants (Kumar and Nair, 2004; Peyre *et al.*, 2006). Some edible fruit yielding plants in the

homegardens are cultivated and they may represent either native or introduced species. In the homegardens, one can also see some non-crop native edible species. For instance, in a study conducted in coffee-based homegardens of the State about 101 fruit tree species were documented (Chandrashekara, 2009). However, detailed inventory of edible non-crop plant species in agroforestry systems prevailing in different agroclimatic zones in the State is lacking. Similarly, despite the fact that the tribal landscape of Kerala has a high ecological, landuse and cultural diversity, little ethnobotanical research on edible non-crop plants has been carried out. Thus it was proposed to study diversity, management and utilisation of non-crop edible plants in the agroforestry and tribal landscape of Kerala. The specific objectives of the present study were to identify and quantify of edible non-crop plants in homegardens and tribal landscape of Kerala and also to determine their nutritional value.

STUDY AREA AND CLIMATE

The study was conducted in Karakkode Village of Vazhikadavu Panchayat, Malappuram District, Kerala located at $76^0$19' to 76^0 23'E Longitude and 11^0 23' to 11^0 25' N Latitude and in the Vaniampuzha forest tract (76^0 12' to 76^0 15'E Longitude and 11^0 26' to 11^0 28' N Latitude). In the Vaniampuzha forest tract, a forest patch adjacent to a hamlet of the Panians, a forest –dwelling tribal community was selected. In each location, an area of 3 km x 1 km was selected. The area was divided into 200 m x 200 m grid and the grid intersection points were marked using a GPS. In the Karakkode Village, out of 90 grid intersection points 48 points represented homegardens and all these homegardens were selected for the study. In the Vaniampuzha forest also 48 points were randomly selected.

The climate in the study area is typically monsoonal with annual rainfall varying from 1621mm to 3271 mm (mean over 1990-2007: 2542mm). More than 65% of annual rainfall is drawn from the southwest monsoon during June- August period. The northeast monsoon, which sets in October and lasts till the end of November, accounts for much less rainfall (hardly 25% of annual rainfall). The mean annual maximum and minimum temperatures are 35°C and 15°C, respectively.

METHODS

Species selection

In each point, three transects, each of 40 m x 10 m in size were marked. Each transect was divided into 16 quadrats, each of 5 m x 5m in size. All the herbs and shrubs growing in each quadrat were identified. After preparing the list of plants identified from all homegardens, at least one person from each homegarden accompanied the project staff to identify the edible plants in his/her homegarden. Similarly, in tribal hamlets also edible plants were identified. These exercises have led to identify 33 species which are edible non-crop plants. Information on plant parts used, frequency of collection and management details were also collected.

Biomass estimation

Three 1 m x 1 m sub-quadrats nested in each of the 5 m x 5 m quadrats were laid. All herbs and shrub species present in each sub-quadrat were harvested and sorted species-wise. For the present study only edible- non-crop plant species that were identified by the informants were considered. The above ground parts of the plants were weighed after air drying for the constant weight.

Determination of nutrient composition

About 1 g of fresh part of edible stem/leaf sample of each species was taken and washed thoroughly with distilled water. The samples were dried in hot air oven at 70° C for a constant weight. The protein content was estimated from the Kjeldhal nitrogen using a conversion factor of 6.25, while the lipid content was estimated by extracting a known weight of powdered plant sample with petroleum ether using the Labconco ether extraction apparatus (AOAC, 1984). Crude fibre was determined by acid and alkali digestion methods (Raghuramulu *et.al.,* 1983). The ash content was determined by combusting the plant materials in silica crucibles in a muffle furnace at 620^{0} C for 3 hours. The ash obtained after combustion were used to prepare the ash solution, which in turn was used for the estimation of calcium and phosphorous. Calcium was precipitated in acidic medium as insoluble calcium oxalate by adding saturated ammonium oxalate solution. The precipitate was dissolved in dilute sulphuric acid (1 : 9), heated and the oxalic acid thus released was

titrated against standard potassium permanganate solution in warm condition (60^0 C) to get the calcium content of the sample (Raghuramulu *et.al.*,1983). Phosphorus was determined spectrophotometrically using the Vendate's solution (AOAC, 1984) when iron was determined by the Atomic absorption spectrophotometer method.

RESULTS AND DISCUSSION

Herbaceous and shrub species of 27 edible non-crop plants belonging to 22 genera and 17 families were found in the homegardens and tribal landscape (Table 1). In 22 species, edible part is leaf while in the remaining 5 species whole plant is edible. In the case of *Cassia occidentalis* and *Cassia tora* only the tender leaves are used. Among the 27 species, 6 species namely, *Cassia occidentalis, Cassia tora, Centella asiatica, Oxalis corniculata, Phyllanthus urinaria and Portulaca oleracea* were found in more than 40 homegardens (Table 1). These species are known for their natural regeneration and quick establishment in the homegardens of Kerala (Jose and Shanmugaratnam, 1993). A wide distribution of these species in homegardens can also be attributed to the fact that they are known, for their food and medicinal values. *Lysianthes laevis* was the least represented species (in 9 out of 48 homegardens). A significant positive correlation (r= 0.9265, n= 27 species) was noted between the number of homegardens of occurrence and number of homegardens where the species are used. In the plots adjacent to the tribal settlement, *Alternanthera bettzickiana* and *Alternanthera pungens* were not found. Among the 25 species recorded eight species namely, *Alternanthera sessilis, Amaranthus caudatus, Amaranthus spinosus, Bacopa monnieri, Cassia occidentalis, Cassia tora, Diplazium esculentum and Phyllanthus urineria* were recorded from more than 40 plots (Table 2). In these plots also, *Lysianthes laevis* was the least represented species (in 5 out of 48 plots).

Even though in some homegardens, the edible non-crop plants are not in use, majority of the family members are aware of their importance as edible plants. Adult male and female members were aware the uses of about 76-85% of the edible non-crop plant species growing in their homegardens while the children knew the use of only 45-60% of species. In the tribal hamlet all the informants knew the use of all the species identified.

Table 1. Botanical name, common name, parts used, number of homegardens of occurrence and edible part of non-crop plants in homegardens of Karakkode Village in Kerala, India.

No.	Species name	Family	Common name	Part/s used	Number of homegardens of occurrence	Number of homegardens where plants are used
1.	*Achyranthes aspera* L.	Amaranthaceae	Valiyakadaladi	Leaf	32	10
2.	*Achyranthes bidentata* Blume	Amaranthaceae	Kozhivalan	Leaf	28	9
3.	*Alternanthera bettzickiana* (Regel) G.Nicholson	Amaranthaceae	Cherucheera	Leaf	26	13
4.	*Alternanthera pungens* Kunth	Amaranthaceae	Minnamkkanni	Leaf	18	10
5.	*Alternanthera sessilis* (L.) R.Br. ex DC.	Amaranthaceae	Ponnamkkanni	Leaf	33	16
6.	*Amaranthus caudatus* L.	Amaranthaceae	Kattucheera	Leaf	38	21
7.	*Amaranthus spinosus* L.	Amaranthaceae	Mullancheera	Whole plant	36	19
8.	*Bacopa monnieri* (L.) Wettst.	Scrophulariaceae	Brahmichappu	Whole plant	36	28
9.	*Bidens biternata* (Lour.) Merr. & Sherff	Asteraceae	Alanchappu	Leaf	25	12
10.	*Boerhaavia diffusa* L.	Nyctaginaceae	Thazhuthama	Whole plant	33	27
11.	*Cassia occidentalis* L.	Caesalpiniaceae	Poninthavara	Tender leaf	44	28
12.	*Cassia tora* L.	Caesalpiniaceae	Thavara	Tender leaf	45	36
13.	*Centella asiatica* (L.) Urb.	Apiaceae	Muthilila	Leaf	43	29
14.	*Cissus discolor* Blume	Vitaceae	Vallimaruma	Whole plant	26	12

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Table 1 (cont'd). Botanical name, common name, parts used, number of homegardens of occurrence and edible part of non-crop plants in homegardens of Karakkode Village in Kerala, India.

No.	Species name	Family	Common name	Part/s used	Number of homegardens of occurrence	Number of homegardens where plants are used
15.	*Cleome viscosa* L.	Capparidaceae	Naikkadugu	Leaf	20	12
16.	*Commelina benghalensis* L.	Commelinaceae	Kannisoppu	Leaf	38	25
17.	*Cyathula prostrata* (L.) Blume	Amaranthaceae	Cherukadaladi	Leaf	16	8
18.	*Diplazium esculentum* (Retz.) Sw.	Athyriaceae	Churuli	Whole plant	36	27
19.	*Emilia sonchifolia* (L.) DC. ex DC.	Asteraceae	Muyalcheviyan	Leaf	19	12
20.	*Euphorbia hirta* L.	Euphorbiaceae	Palcheera	Leaf	15	7
21.	*Lycianthes laevis* (Dunal) Bitter	Solanaceae	Kattumudunga	Leaf	9	3
22.	*Oxalis corniculata* L.	Oxalidaceae	Puliyarila	Leaf	41	28
23.	*Phyllanthus urinaria* L.	Euphorbiaceae	Keezharnelli	Leaf	45	27
24.	*Portulaca oleracea* L.	Portulacaceae	Kozhupacheera	Leaf	44	32
25.	*Remusatia vivipara* (Roxb.) Schott	Araceae	Marachembu	Leaf	19	12
26.	*Talinum cuneifolium* (Vahl) Willd.	Portulacaceae	Sambarcheera	Leaf	38	28
27.	*Zehneria mysorensis* (Wight & Arn.) Arn.	Cucurbitaceae	Aliyanchappu	Leaf	28	9

Table 2. Botanical name, common name, parts used, number of plots of occurrence and edible part/s of non-crop plants in the tribal landscape at Vaniampuzha in Kerala

No.	Species name	Family	Common name	Part/s used	Number of plots of occurrence
1.	*Achyranthes aspera* L.	Amaranthaceae	Valiyakadaladi	Leaf	25
2.	*Achyranthes bidentata* Blume	Amaranthaceae	Kozhivalan	Leaf	23
3.	*Alternanthera sessilis* (L.) R.Br. ex DC.	Amaranthaceae	Ponnamkkanni	Leaf	45
4.	*Amaranthus caudatus* L.	Amaranthaceae	Kattucheera	Leaf	43
5.	*Amaranthus spinosus* L.	Amaranthaceae	Mullancheera	Whole plant	46
6.	*Bacopa monnieri* (L.) Wettst.	Scrophulariaceae	Brahmichappu	Whole plant	42
7.	*Bidens biternata* (Lour.) Merr. & Sherff	Asteraceae	Alanchappu	Leaf	36
8.	*Boerhaavia diffusa* L.	Nyctaginaceae	Thazhuthama	Whole plant	37
9.	*Cassia occidentalis* L.	Caesalpiniaceae	Poninthavara	Tender leaf	40
10.	*Cassia tora* L.	Caesalpiniaceae	Thavara	Tender leaf	42
11.	*Centella asiatica* (L.) Urb.	Apiaceae	Muthilila	Leaf	32
12.	*Cissus discolor* Blume	Vitaceae	Vallimaruma	Whole plant	21

-----cont'd----

Table 2 (cont'd). Botanical name, common name, parts used, number of plots of occurrence and edible part/s of non-crop plants in the tribal landscape at Vaniampuzha in Kerala

No.	Species name	Family	Common name	Part/s used	Number of plots of occurrence
13.	*Cleome viscosa* L.	Capparidaceae	Naikkadugu	Leaf	16
14.	*Commelina benghalensis* L.	Commelinaceae	Kannisoppu	Leaf	32
15.	*Cyathula prostrata* (L.) Blume	Amaranthaceae	Cherukadaladi	Leaf	24
16.	*Diplazium esculentum* (Retz.) Sw.	Athyriaceae	Churuli	Whole plant	44
17.	*Emilia sonchifolia* (L.) DC. ex DC.	Asteraceae	Muyalcheviyan	Leaf	24
18.	*Euphorbia hirta* L.	Euphorbiaceae	Palcheera	Leaf	18
19.	*Lycianthes laevis* (Dunal) Bitter	Solanaceae	Kattumudunga	Leaf	5
20.	*Oxalis corniculata* L.	Oxalidaceae	Puliyarila	Leaf	32
21.	*Phyllanthus urinaria* L.	Euphorbiaceae	Keezharnelli	Leaf	40
22.	*Portulaca oleracea* L.	Portulacaceae	Kozhupacheera	Leaf	38
23.	*Remusatia vivipara* (Roxb.) Schott	Araceae	Marachembu	Leaf	24
24.	*Talinum cuneifolium* (Vahl) Willd.	Portulacaceae	Sambarcheera	Leaf	32
25.	*Zehneria mysorensis* (Wight & Arn.) Arn.	Cucurbitaceae	Aliyanchappu	Leaf	20

In the study area, broadly two types of collection of edible non-crop plants were noticed. Majority of the adult women do make special collection trips to collect plants. However, such collection trips were generally high for certain species such as *Alternanthera bettzickiana*, *Alternanthera pungens Amaranthus caudatus*, *Amaranthus spinosus, Cassia occidentalis, Cassia tora* and *Diplazium esculentum*. On the other hand, the leaves/whole plants of *Centella asiatica, Oxalis corniculata, Phyllanthus urinaria* are collected during casual observation. According to respondents, apart from availability, collection of plants is determined by the taste and preference of family members.

Management strategies adopted for different species varied considerably. However, in none of the homegardens no special care was given to protect and nurture any of the species studied. The study also revealed that 20 out of 27 edible non-crop species are tolerated in more than 40 homegardens. This means that they germinate and grow spontaneously and are not removed because of their uses. The collective information provided by the informant also indicated that the species are tolerated for a multiple of reasons such as medicinal and culinary uses and their ability to improve soil fertility.

In homegardens, the average biomass of *Cassia occidentalis* was significantly ($P<0.05$) more than the rest of species studied (Table 3). The mean aboveground biomass of 11 species was less than 100 g m^{-2} with significantly lowest value recorded for *Commelina benghalensis*. About 50% of the total number of species studied recorded the aboveground biomass within the range of 101-400 g m^{-2}.

Around the tribal settlement, *Alternanthera sessilis*, *Boerhaavia diffusa* and *Cassia tora* were found growing well with aboveground biomass of each species more than 400 g m^{-2} (Table 3). Perhaps due to dryness of soil in these plots, species such as *Bacopa monnieri, Cleome viscosa, Commelina benghalensis, Emilia sonchifolia, Portulaca oleracea, Lysianthes laevis* recorded significantly low biomass.

Table 3. **Aboveground biomass (mean± SD) of edible non-crop plant species in homegardens and tribal landscape of Kerala.**

No.	Species name	Aboveground biomass ($g\ m^{-2}$)*	
		Homegardens	Forest plots
1.	*Achyranthes aspera* L.	187±23^{f}	289±56^{d}
2.	*Achyranthes bidentata* Blume	108±14^{h}	178±32^{fg}
3.	*Alternanthera bettzickiana* (Regel) G.Nicholson	348±24^{b}	0
4.	*Alternanthera pungens* Kunth	218±29^{e}	0
5.	*Alternanthera sessilis* (L.) R.Br. ex DC.	387±56^{ab}	412±36^{a}
6.	*Amaranthus caudatus* L.	253±23^{d}	123±32^{gh}
7.	*Amaranthus spinosus* L.	187±14^{f}	218±23^{ef}
8.	*Bacopa monnieri* (L.) Wettst.	56±6^{j}	26±9^{k}
9.	*Bidens biternata* (Lour.) Merr. & Sherff	108±10^{h}	186±26^{f}
10.	*Boerhaavia diffusa* L.	276±12^{cd}	402±68^{ab}
11.	*Cassia occidentalis* L.	403±32^{a}	378±98^{bc}
12.	*Cassia tora* L.	287±29^{c}	456±98^{a}
13.	*Centella asiatica* (L.) Urb.	78±12^{i}	109±41^{h}
14.	*Cissus discolor* Blume	136±45^{g}	56±21^{jk}
15.	*Cleome viscosa* L.	48±11^{j}	23±9^{kl}
16.	*Commelina benghalensis* L.	28±12^{l}	28±6k
17.	*Cyathula prostrata* (L.) Blume	36±8^{jk}	78±12^{hi}
18.	*Diplazium esculentum* (Retz.) Sw.	287±56^{c}	336±61^{cd}
19.	*Emilia sonchifolia* (L.) DC. ex DC.	19±10^{l}	28±8^{l}
20.	*Euphorbia hirta* L.	109±18^{h}	198±26^{f}
21.	*Lycianthes laevis* (Dunal) Bitter	56±23^{j}	12±8^{l}
22.	*Oxalis corniculata* L.	32±7^{k}	32±7^{k}
23.	*Phyllanthus urinaria* L.	76±8^{i}	132±12^{g}
24.	*Portulaca oleracea* L.	58±12^{j}	32±9^{k}
25.	*Remusatia vivipara* (Roxb.) Schott	178±56^{f}	268±32de
26.	*Talinum cuneifolium* (Vahl) Willd.	258±32^{d}	132±43^{g}
27.	*Zehneria mysorensis* (Wight & Arn.) Arn.	46±26^{j}	65±13^{i}

*, Significantly different means within a system (homegarden/forest plot) for aboveground biomass are indicated by different letters in the superscript (analysis of variance, <0.05, n=3).

Nutrient composition

Nutritionally, the edible non-crop species could contribute substantially to protein, mineral and crude fibre intake. The protein content of the species which ranged from 19.3 mg g^{-1} to 54.33 mg g^{-1} and it was highest in *Cleome viscosa, Diplazium esculentum, Remusatia vivipara* and *Alternanthera bettzickiana while Bidens biternata, Cassia occidentalis* and *Commelina benghalensis* had the least (Table 4). It was observed that the protein content of these non-crop species were comparable with or higher than that of the vegetables like lettuce, cabbage and spinach (Gopalan *et al.*, 2004).

Among the species studied, *Remusatia vivipara* and *Cleome viscosa* were with the highest fat content (0.015-0.016 mg g^{-1}) while species such as *Amaranthus spinosus, Emelia sonchifolia, Bidens biternata* and *Commelina benghalensis* with the lowest fat (0.004 mg g^{-1}). However, the fat content in all these species were comparable with those reported for several conventional leafy vegetables consumed in India (Gopalan *et al.*, 2004).

All the species investigated in the present study were also good source of crude fibre with the highest concentration of 49.8 mg g^{-1} in *Diplazium esculentum* and lowest concentration of 12.6 to 13.4 mg g^{-1} in *Amaranthus spinosus, Bacopa monnieri* and *Oxalis corniculata*.

In terms of their mineral contents, the edible non-crop plants were rich in calcium and Iron (Table 4). Total mineral content was significantly high in *Cassia tora* and *Cassia occidentalis* and low in *Cleome viscosa* and *Commelina benghalensis. Diplazium esculentum* and *Talinum cuneifolium* were rich in calcium (12.6 to 13.3 mg g^{-1}) and *Talinum cuneifolium* was also rich in iron (0.8 mg g^{-1}). On the other hand, *Amaranthus caudatus* and *Bidens bidentata* were with less content of calcium (3.3 to 3.5 mg g^{-1}) and *Bacopa monnieri, Commelina benghalensis and Amaranthus caudatus* were poor in iron *(0.2 to 0.25* mg g^{-1}). However, the present study revealed that total mineral contents, calcium and iron were within the range reported for several leafy vegetables consumed in tropical countries (Yildirim *et al.*, 2001; Gopalan *et al.*, 2004; McBurney *et al.*, 2004).

Table 4. Nutrient composition of edible non-crop plant species growing in homegardens and tribal landscape of Kerala.

No.	Species name	Protein (mg/g)*	Fat (mg/g)	Fibre (mg/g)	Minerals (mg/g))	Calcium (mg/g)	Phosphorus (mg/g)	Iron (mg/g)
1.	*Achyranthes aspera*	35.0^{de}	0.009^{d}	15.3^{j}	32.6^{i}	4.3^{o}	1.75^{d}	0.4^{f}
2.	*Achyranthes bidentata*	28.0^{f}	0.008^{e}	26.3^{h}	36.9^{h}	3.3^{p}	1.3^{e}	0.6^{d}
3.	*Alternanthera bettzickiana*	52.3^{ab}	0.013^{b}	31.3^{g}	44.2^{f}	4.9^{n}	1.7^{d}	0.5^{e}
4.	*Alternanthera pungens*	48.6^{b}	0.01^{d}	39.3^{e}	47.6^{e}	5.3^{m}	3.2^{a}	0.4^{f}
5.	*Alternanthera sessilis*	49.8^{b}	0.009^{d}	41.9^{d}	53.6^{c}	6.9^{j}	1.9^{c}	0.3^{h}
6.	*Amaranthus caudatus*	28.3^{f}	0.007^{e}	29.6^{g}	43.7^{f}	3.5^{p}	2.1^{b}	0.2^{h}
7.	*Amaranthus spinosus*	28.7^{f}	0.004^{g}	12.6^{k}	48.9^{e}	4.9^{n}	2.3^{b}	0.35^{g}
8.	*Bacopa monnieri*	39.7^{d}	0.005^{f}	12.9^{k}	55.8^{b}	7.9^{h}	1.6^{d}	0.25^{h}
9.	*Bidens biternata*	19.3^{h}	0.004^{g}	31.9^{g}	37.3^{h}	6.3^{k}	1.4^{e}	0.4^{f}
10.	*Boerhaavia diffusa*	44.3^{c}	0.008^{e}	41.3^{d}	43.9^{f}	7.5^{i}	1.9^{c}	0.6^{d}
11.	*Cassia occidentalis*	20.2^{h}	0.007^{e}	35.0^{f}	57.9^{a}	8.9^{e}	1.9^{c}	0.65^{cd}
12.	*Cassia tora*	49.2^{b}	0.013^{b}	32^{fg}	58.3^{a}	11.3^{b}	1.35^{e}	0.75^{b}
13.	*Centella asiatica*	48.6^{b}	0.007^{e}	44.3^{c}	47.9^{e}	9.3^{d}	1.2^{f}	0.45^{ef}
14.	*Cissus discolor*	36.7^{d}	0.005^{fg}	38.9^{e}	32.1^{i}	5.8^{l}	0.5^{h}	0.6^{d}
15.	*Cleome viscosa*	54.3^{a}	0.015^{a}	29.7^{g}	27.8^{j}	4.9^{n}	0.4^{h}	0.25^{h}

*** Significantly different means for a given parameter are indicated by different letters in the superscript (analysis of variance, <0.05, n=3).**

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Table 4 (cont'd). Nutritional values of edible non-crop plant species growing in homegardens and tribal landscape of Kerala.

No.	Species name	Protein (mg/g)*	Fat (mg/g)	Fibre (mg/g)	Minerals (mg/g)	Calcium (mg/g)	Phosphorus (mg/g)	Iron (mg/g)
16.	*Commelina benghalensis*	21.0^{h}	0.004^{g}	25.9^{h}	25.7^{j}	6.1^{k}	0.8^{g}	0.25^{h}
17.	*Cyathula prostrata*	24.3^{gh}	0.007^{e}	32.3^{f}	31.3^{i}	7.3^{i}	1.2^{f}	0.35^{g}
18.	*Diplazium esculentum*	54.2^{a}	0.009^{d}	49.8^{a}	53.2^{c}	13.3^{a}	1.0^{g}	0.6^{d}
19.	*Emilia sonchifolia*	24.1^{gh}	0.004^{g}	29.8^{g}	43.2^{f}	10.2^{c}	0.9^{g}	0.4^{f}
20.	*Euphorbia hirta*	41.3^{c}	0.009^{de}	33.6^{f}	44.9f	8.9^{e}	1.3^{e}	0.45^{ef}
21.	*Lycianthes laevis*	32.4^{e}	0.005^{fg}	18.9^{i}	36.9^{h}	9.2^{de}	0.5^{h}	0.35^{g}
22.	*Oxalis corniculata*	43.3^{c}	0.009^{de}	13.4^{k}	33.8^{i}	8.3^{g}	0.8^{g}	0.6^{d}
23.	*Phyllanthus urinaria*	32.1^{e}	0.006^{f}	41.6^{d}	38.6^{h}	9.2^{de}	0.9^{g}	0.75^{b}
24.	*Portulaca oleracea*	47.3^{bc}	0.012^{c}	38.9^{e}	41.3^{g}	7.9^{h}	0.3^{h}	0.7^{c}
25.	*Remusatia vivipara*	53.6^{a}	0.016^{a}	46.8^{b}	55.8^{b}	11.3^{b}	1.2^{f}	0.75^{b}
26.	*Talinum cuneifolium*	43.2^{c}	0.012^{c}	47.9^{b}	51.3^{d}	12.6^{ab}	1.3^{ef}	0.8^{a}
27.	*Zehneria mysorensis*	31.3e	0.006^{f}	19.2^{i}	32.3^{i}	8.6^{f}	0.9^{g}	0.7^{c}

*** Significantly different means for a given parameter are indicated by different letters in the superscript (analysis of variance, <0.05, n=3).**

CONCLUSIONS

On the basis of the results obtained from the above study, it is concluded that all the 27 species of edible non-crop plants are good source of many nutrients such as protein, fibre, fat and minerals and their nutritive values were greater than many commercially cultivated vegetable. In addition to high nutritive value, majority of these species also have medicinal value. Their consumption could help in alleviating the problem of malnutrition at no cost; therefore, efforts should be made to promote management and utilisation of these less-know plants.

Though the edible non-crop species are managed at a minimal level by tolerance and protection, it is clear that the species are the part of plant diversity in an agricultural environment. Homegardens in the tropics like other land-use systems are not static; their composition and management are gradually changing in response to socio-economic dynamics (Peyre *et al.*, 2006). However, the present study demonstrated an example of a system which is maintaining an important traditional feature i.e. utilisation of non-crop plants. In the context of changing socio-economic scenario, however, efforts are required to strengthen traditional system so that they will maintain optimal combination of ecological and productive features as well as ensure food security and plant diversity in homegardens and rural landscapes.

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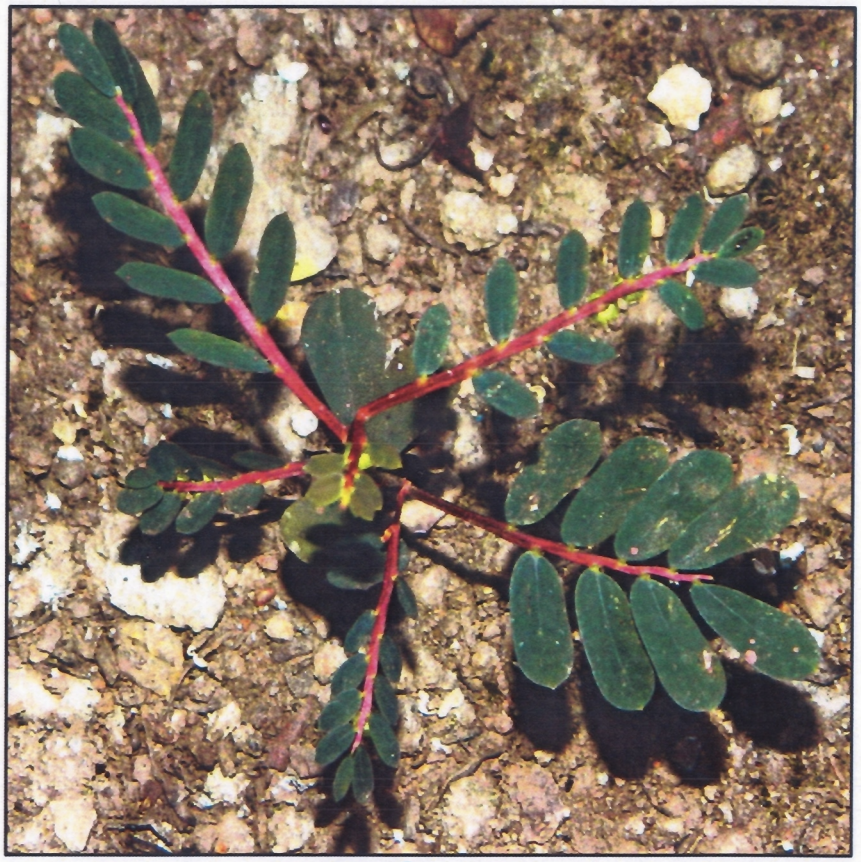
Oxalis corniculata L. - Oxalidaceae - പുളിയാറില

Talinum cuneifolium (Vahl) Willd.
Portulacaceae
സാമ്പാർചീര

Cassia tora L.
Caesalpiniaceae
തവര

Alternanthera bettzickiana (Regel) G.Nicholson - Amaranthaceae - ചെറുചീര

Diplazium esculentum (Retz.) Sw.
Athyriaceae
ചുരുളി



Phyllanthus urinaria L.
Euphorbiaceae
കീഴാർനെല്ലി

ula prostrata (L.) Blume
Amaranthaceae
ചെറുകടലാടി

Amaranthus spinosus L.
Amaranthaceae
മുള്ളൻചീര