

Edible Non-Crop Plants in Homegardens of Kerala: Their Diversity, Management and Nutritive Value

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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 majority of the homegardens. A significant positive correlation between the number of homegardens accommodating and using the species was also noticed. In homegardens, all edible non-crop plants are managed at a minimal level by tolerance and protection. 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. The present study also 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.

Key Words: Agroforestry; Food Security; Non-cultivated Edible Plants; Nutritional Security; Traditional Land-use Pattern.

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 rich with cultivated and managed plant communities. 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). In the homegardens, one can also see some non-crop native edible species. For instance, in coffee-based homegardens of the State out of 101 fruit tree species 46 were cultivated and the rest were non-crop species (Chandrashekara 2009). However, detailed inventory of edible non-crop herbaceous plant species in home-

gardens of the State is lacking. In this context, a study was undertaken on the diversity, management and utilisation of non-crop edible plants in homegardens. The specific objectives of the present study were to identify and quantify of edible non-crop plants in homegardens and determine their nutritional value.

METHODOLOGY

Study Area and Climate

The study was conducted in Karakkode Village (76°19' to 76°23'E Longitude and 11°23' to 11°25' N Latitude) in the mid-land agroclimatic zone of Kerala. 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.

In the village, an area of 3 km x 1 km was selected and divided into 200 m x 200 m grid. The grid intersection points were marked using a GPS. Out of 90 grid intersection points thus obtained 48 points represented homegardens and all these homegardens were selected for the study.

Species Selection

In each of the 48 homegardens, 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. These exercises have led to identify 27 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 °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 °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

Abundance of Edible Non-crop Plants in Homegardens

Herbaceous and shrub species of 27 edible non-crop plants belonging to 22 genera and 17 families were found in the homegardens (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

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.

Species name	Family	Common name	Part/s used	Number of Homegardens of occurrence	where plant is used
<i>Achyranthes aspera</i> L.	Amaranthaceae	Valiyakadaladi	Leaf	32	10
<i>Achyranthes bidentata</i> Blume	Amaranthaceae	Kozhivalan	Leaf	28	9
<i>Alternanthera bettzickiana</i> (Regel) G.Nicholson	Amaranthaceae	Cherucheera	Leaf	26	13
<i>Alternanthera pungens</i> Kunth	Amaranthaceae	Minnamkkanni	Leaf	18	10
<i>Alternanthera sessilis</i> (L.) R.Br. ex DC.	Amaranthaceae	Ponnamkkanni	Leaf	33	16
<i>Amaranthus caudatus</i> L.	Amaranthaceae	Kattucheera	Leaf	38	21
<i>Amaranthus spinosus</i> L.	Amaranthaceae	Mullancheera	Whole plant	36	19
<i>Bacopa monnieri</i> (L.) Wettst.	Scrophulariaceae	Brahmichappu	Whole plant	36	28
<i>Bidens biternata</i> (Lour.) Merr. & Sherff	Asteraceae	Alanchappu	Leaf	25	12
<i>Boerhaavia diffusa</i> L.	Nyctaginaceae	Thazhuthama	Whole plant	33	27
<i>Cassia occidentalis</i> L.	Caesalpiniaceae	Poninthavara	Tender leaf	44	28
<i>Cassia tora</i> L.	Caesalpiniaceae	Thavara	Tender leaf	45	36
<i>Centella asiatica</i> (L.) Urb.	Apiaceae	Muthilila	Leaf	43	29
<i>Cissus discolor</i> Blume	Vitaceae	Vallimaruma	Whole plant	26	12
<i>Cleome viscosa</i> L.	Capparidaceae	Naikkadugu	Leaf	20	12
<i>Commelina benghalensis</i> L.	Commelinaceae	Kannisoppu	Leaf	38	25
<i>Cyathula prostrata</i> (L.) Blume	Amaranthaceae	Cherukadaladi	Leaf	16	8
<i>Diplazium esculentum</i> (Retz.) Sw.	Athyriaceae	Churuli	Whole plant	36	27
<i>Emilia sonchifolia</i> (L.) DC. ex DC.	Asteraceae	Muyalcheviyan	Leaf	19	12
<i>Euphorbia hirta</i> L.	Euphorbiaceae	Palcheera	Leaf	15	7
<i>Lycianthes laevis</i> (Dunal) Bitter	Solanaceae	Kattumudunga	Leaf	9	3
<i>Oxalis corniculata</i> L.	Oxalidaceae	Puliyarila	Leaf	41	28
<i>Phyllanthus urinaria</i> L.	Euphorbiaceae	Keezharnelli	Leaf	45	27
<i>Portulaca oleracea</i> L.	Portulacaceae	Kozhupacheera	Leaf	44	32
<i>Remusatia vivipara</i> (Roxb.) Schott	Araceae	Marachembu	Leaf	19	12
<i>Talinum cuneifolium</i> (Vahl) Willd.	Portulacaceae	Sambarcheera	Leaf	38	28
<i>Zehneria mysorensis</i> (Wight & Arn.) Arn.	Cucurbitaceae	Aliyanchappu	Leaf	28	9

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. *Lycianthes 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.

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.

Collection

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

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.

Biomass

In homegardens, the average biomass of *Cassia occidentalis* was significantly ($P < 0.05$) more than the rest of species studied (Table 2). 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 $101\text{-}400 \text{ g m}^{-2}$.

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 3). 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 ($0.015\text{-}0.016 \text{ mg g}^{-1}$) 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 was comparable with that 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*.

Table 2. Aboveground biomass (mean \pm SD) of edible non-crop plant species in homegardens of Kerala.

Species name	Aboveground biomass (g m^{-2})*
<i>Achyranthes aspera</i>	187 ± 23^f
<i>Achyranthes bidentata</i>	108 ± 14^h
<i>Alternanthera bettzickiana</i>	348 ± 24^b
<i>Alternanthera pungens</i>	218 ± 29^e
<i>Alternanthera sessilis</i>	387 ± 56^{ab}
<i>Amaranthus caudatus</i>	253 ± 23^d
<i>Amaranthus spinosus</i>	187 ± 14^f
<i>Bacopa monnieri</i>	56 ± 6^i
<i>Bidens biternata</i>	108 ± 10^h
<i>Boerhaavia diffusa</i>	276 ± 12^{cd}
<i>Cassia occidentalis</i>	403 ± 32^a
<i>Cassia tora</i>	287 ± 29^c
<i>Centella asiatica</i>	78 ± 12^i
<i>Cissus discolor</i>	136 ± 45^g
<i>Cleome viscosa</i>	48 ± 11^j
<i>Commelina benghalensis</i>	28 ± 12^l
<i>Cyathula prostrata</i>	36 ± 8^{jk}
<i>Diplazium esculentum</i>	287 ± 56^c
<i>Emilia sonchifolia</i>	19 ± 10^l
<i>Euphorbia hirta</i>	109 ± 18^h
<i>Lycianthes laevis</i>	56 ± 23^j
<i>Oxalis corniculata</i>	32 ± 7^k
<i>Phyllanthus urinaria</i>	76 ± 8^i
<i>Portulaca oleracea</i>	58 ± 12^j
<i>Remusatia vivipara</i>	178 ± 56^f
<i>Talinum cuneifolium</i>	258 ± 32^d
<i>Zehneria mysorensis</i>	$46 \pm 26^{j*}$,

Significantly different means for aboveground biomass are indicated by different letters in the superscript (analysis of variance, < 0.05 , $n = 48$ homegardens).

In terms of their mineral contents, the edible non-crop plants were rich in calcium and iron (Table 3). 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*

Table 3. Nutrient composition (mg/g) of edible non-crop plant species growing in homegardens and tribal landscape of Kerala.

Species name	Protein	Fat	Fibre	Minerals	Calcium	Phosphorus	Iron
<i>Achyranthes aspera</i>	35.0 ^{de}	0.009 ^d	15.3 ^j	32.6 ⁱ	4.3 ^o	1.75 ^d	0.4 ^f
<i>Achyranthes bidentata</i>	28.0 ^f	0.008 ^e	26.3 ^h	36.9 ^h	3.3 ^p	1.3 ^e	0.6 ^d
<i>Alternanthera bettzickiana</i>	52.3 ^{ab}	0.013 ^b	31.3 ^g	44.2 ^f	4.9 ⁿ	1.7 ^d	0.5 ^e
<i>Alternanthera pungens</i>	48.6 ^b	0.01 ^d	39.3 ^c	47.6 ^c	5.3 ^m	3.2 ^a	0.4 ^f
<i>Alternanthera sessilis</i>	49.8 ^b	0.009 ^d	41.9 ^d	53.6 ^c	6.9 ^j	1.9 ^c	0.3 ^h
<i>Amaranthus caudatus</i>	28.3 ^f	0.007 ^e	29.6 ^g	43.7 ^f	3.5 ^p	2.1 ^b	0.2 ^h
<i>Amaranthus spinosus</i>	28.7 ^f	0.004 ^g	12.6 ^k	48.9 ^e	4.9 ⁿ	2.3 ^b	0.35 ^g
<i>Bacopa monnieri</i>	39.7 ^d	0.005 ^f	12.9 ^k	55.8 ^b	7.9 ^h	1.6 ^d	0.25 ^h
<i>Bidens biternata</i>	19.3 ^h	0.004 ^g	31.9 ^g	37.3 ^h	6.3 ^k	1.4 ^e	0.4 ^f
<i>Boerhaavia diffusa</i>	44.3 ^c	0.008 ^e	41.3 ^d	43.9 ^f	7.5 ⁱ	1.9 ^c	0.6 ^d
<i>Cassia occidentalis</i>	20.2 ^h	0.007 ^e	35.0 ^f	57.9 ^a	8.9 ^e	1.9 ^c	0.65 ^{cd}
<i>Cassia tora</i>	49.2 ^b	0.013 ^b	32 ^{fg}	58.3 ^a	11.3 ^b	1.35 ^c	0.75 ^b
<i>Centella asiatica</i>	48.6 ^b	0.007 ^e	44.3 ^c	47.9 ^e	9.3 ^d	1.2 ^f	0.45 ^{ef}
<i>Cissus discolor</i>	36.7 ^d	0.005 ^{fg}	38.9 ^e	32.1 ⁱ	5.8 ^l	0.5 ^h	0.6 ^d
<i>Cleome viscosa</i>	54.3 ^a	0.015 ^a	29.7 ^g	27.8 ^j	4.9 ⁿ	0.4 ^h	0.25 ^h
<i>Commelina benghalensis</i>	21.0 ^h	0.004 ^g	25.9 ^h	25.7 ^j	6.1 ^k	0.8 ^g	0.25 ^h
<i>Cyathula prostrata</i>	24.3 ^{gh}	0.007 ^e	32.3 ^f	31.3 ⁱ	7.3 ⁱ	1.2 ^f	0.35 ^g
<i>Diplazium esculentum</i>	54.2 ^a	0.009 ^d	49.8 ^a	53.2 ^c	13.3 ^a	1.0 ^g	0.6 ^d
<i>Emilia sonchifolia</i>	24.1 ^{gh}	0.004 ^g	29.8 ^g	43.2 ^f	10.2 ^c	0.9 ^g	0.4 ^f
<i>Euphorbia hirta</i>	41.3 ^c	0.009 ^{de}	33.6 ^f	44.9 ^f	8.9 ^e	1.3 ^e	0.45 ^{ef}
<i>Lycianthes laevis</i>	32.4 ^c	0.005 ^{fg}	18.9 ⁱ	36.9 ^h	9.2 ^{de}	0.5 ^h	0.35 ^g
<i>Oxalis corniculata</i>	43.3 ^c	0.009 ^{de}	13.4 ^k	33.8 ⁱ	8.3 ^g	0.8 ^g	0.6 ^d
<i>Phyllanthus urinaria</i>	32.1 ^c	0.006 ^f	41.6 ^d	38.6 ^h	9.2 ^{de}	0.9 ^g	0.75 ^b
<i>Portulaca oleracea</i>	47.3 ^{bc}	0.012 ^c	38.9 ^e	41.3 ^g	7.9 ^h	0.3 ^h	0.7 ^c
<i>Remusatia vivipara</i>	53.6 ^a	0.016 ^a	46.8 ^b	55.8 ^b	11.3 ^b	1.2 ^f	0.75 ^b
<i>Talinum cuneifolium</i>	43.2 ^c	0.012 ^c	47.9 ^b	51.3 ^d	12.6 ^{ab}	1.3 ^{ef}	0.8 ^a
<i>Zehneria mysorensis</i>	31.3 ^e	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).

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, McBurney et al. 2004).

CONCLUSIONS

On the basis of the results obtained from this 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 and nutritive security and plant diversity in homegardens and rural landscapes.

ACKNOWLEDGEMENTS

This project was sponsored by the Kerala Forest Research Institute (KFRI) under the Plan Fund Grant. I thank Dr. K.V. Sankaran, former Director, KFRI for his support and encouragement. Thanks are also due to farmers of Karakkode village to conduct field studies and to provide valuable information on plants. I also thank Ms. R.S. Neethu and E.C. Baiju for their help in field works and data processing.

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Received 13 July 2015

Accepted 18 October 2015