

Research article

Identification, market availability and consumption of green leafy vegetables in Batticaloa, Sri Lanka

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[Accepted: 10 July 2014]

Abstract: Preliminary market visits, market survey and interviews with study subjects were conducted in the coastal line extending from Kallar to Oddamavadi in the Batticaloa district, Sri Lanka. Fifty nine species of Green Leafy vegetables (GLVs) were identified, which were consumed for food and medicinal purposes. Among the identified species, 29 were supplied by the markets in the Batticaloa district and the others from home gardens and forest lands. Thirty one species were consumed commonly and their average consumption was 59%. Twenty eight species were consumed rarely and their average consumption was 2%. Availability of GLVs depends on size of the markets, seasonality, and easy access of supply area to markets and attitude of people. GLVs were consumed both in cooked and uncooked states. *Lactuca sativa* was the only GLV consumed in uncooked form for food purpose and *Coleus amboinicus*, *Momordica charantia*, *Ocimum tenuiflorum* and *Tribulus terrestris* were the only GLVs consumed in uncooked form for medicinal purpose. Average consumption of commonly consumed leafy vegetables was 31% and 28 % on weekly and monthly basis respectively. But rarely consumed leafy vegetables were consumed less than 2% on weekly as well as on monthly basis. Eighty eight percent of the study subjects consumed GLVs immediately and 12% of study subjects consumed after 2-3 days of purchasing/harvesting. Excess GLVs were stored mainly at room temperature ($30\pm 2^{\circ}\text{C}$) and at 4°C for a maximum of 4 days. Sixty five percent of study subjects preferred to store at 4°C and 23% at room temperature.

Keywords: Leafy vegetables - Market survey - Consumption

[Cite as: Mathiventhan U, Sivaganeshan R & Mathiventhan T (2014) Identification, market availability and consumption of green leafy vegetables in Batticaloa, Sri Lanka. *Tropical Plant Research* 1(2): 17–25]

INTRODUCTION

Green leafy vegetables (GLVs) are rich sources of many nutrients and form a major category of vegetable group that have been designated as ‘nature’s anti-aging wonders’. Many vegetables have been exploited as source of antioxidants (Ismail, *et al.*, 2004). Inadequate number of studies, severe shortage of primary data and many information gaps exist regarding availability of green leafy vegetables and their consumption pattern in Batticaloa district. Systematic market surveys may help to identify the commonly available Green leafy vegetables (Mensha *et al.*, 2008). Therefore, this study attempts to identify the edible green leafy vegetables (GLVs) and their consumption pattern.

MATERIALS AND METHODS

Study Sites

The study sites were from Kallar to Oddamavadi of the Batticaloa district, Sri Lanka. Markets, which are available in those study sites, were considered for systematic survey. Ten Market places were selected from the visits that received a steady supply of green leafy vegetable daily (Fig. 1).

Data collection

Preliminary market visits, market survey and interviews with consumers (study subjects) were conducted (Fig. 2). Five study subjects were interviewed, randomly, during each visit to the market. Interviews were

carried out with the semi-structured questionnaire. A total of one thousand subjects were interviewed from the Batticaloa district, at the end of the survey (5 study subjects $\times$ 2 times per month $\times$ 10 places $\times$ 10 months). The interview mainly focused on the followings: (i) types and purpose of consuming green leafy vegetables, (ii) the form of consumption - cooked and/or uncooked, (iii) frequency of consumption, (iv) time taken for consuming after marketing/harvesting and (v) the way of storage of green leafy vegetables, if they were not consumed immediately.

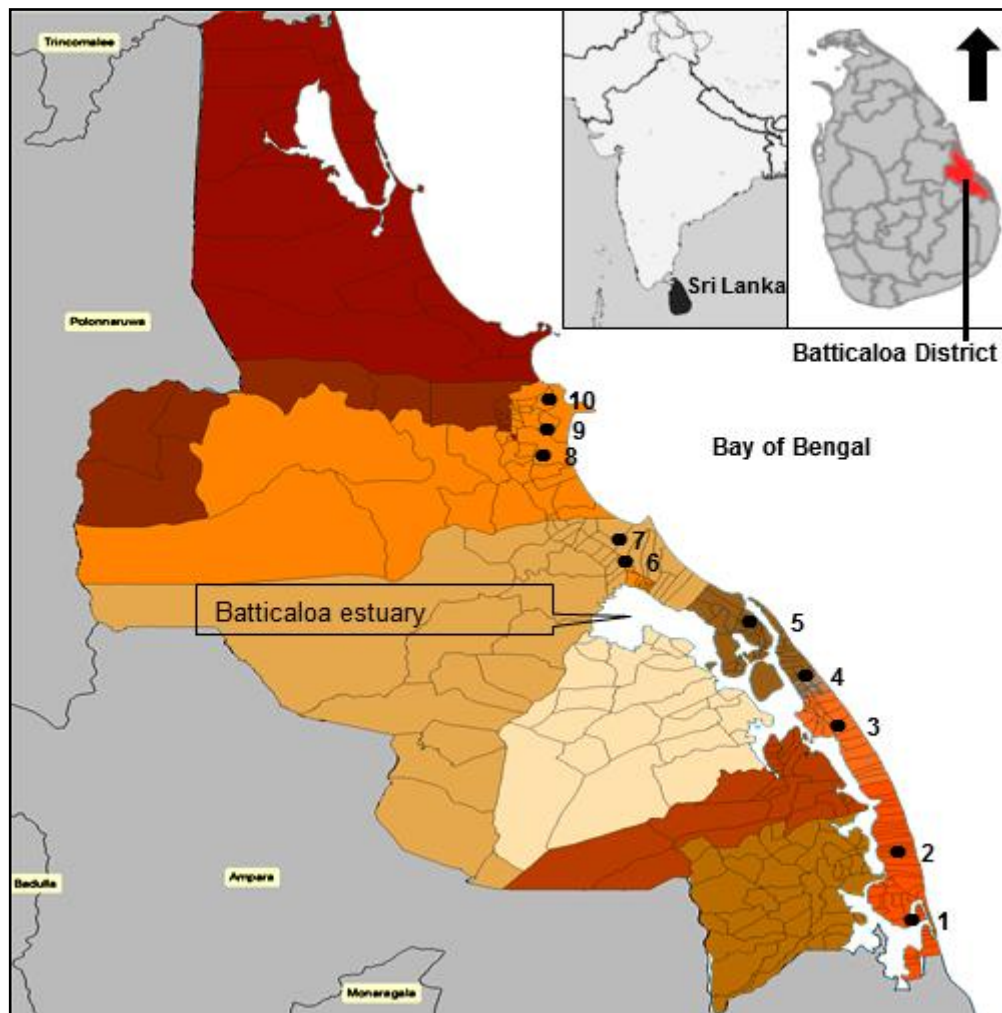


Figure 1. The study sites (market places): 1, Kallar; 2, Kaluwanchikudy; 3, Arayampathy; 4, Kattankudy; 5, Batticaloa; 6, Eravur; 7, Chenkalady; 8, Kiran; 9, Valaichenai; 10, Oddamavadi.



Figure 2. Availability of leafy vegetables (e.g. *Amaranthus* sp., *Acalypha*, *Alternanthera*, *Murraya*, etc.) at A, Batticaloa; B, Kaluwanchikudy.

RESULTS AND DISCUSSION

Identification of Green Leafy Vegetables (GLVs)

Fifty nine plant species were identified belonging to 52 genera and 27 families in the Batticaloa district based on their characteristics feature described by many workers (Jayaweera, 1981; Jayaweera, 1982; Senaratna, 2001; Thirugnanam, 2007). Among them 29 species (49%) were available in the markets (Table 1).

Table1. GLVs identified in the Batticaloa district. Vernacular names in parenthesis (E)-English.

No	Name of GLVs	Vernacular name	Family
1	<i>Acalypha indica</i> L.	Cat's straggle, Indian acalypha (E)	Euphorbiaceae
2	<i>Achyranthes aspera</i> L.	Chaff-flower, Devil's horsewhip (E)	Euphorbiaceae
3	<i>Aerva lanata</i> (L.) juss. ex Shult*	Hongone (E)	Amaranthaceae
4	<i>Allmania nodiflora</i> (L.) R.Br. ex Wight*	-	Amaranthaceae
5	<i>Alternanthera sessilis</i> (L.) R.Br.*	Alligator weed (E)	Amaranthaceae
6	<i>Amaranthus caudatus</i> L.*	Pendant amaranth (E)	Amaranthaceae
7	<i>Amaranthus spinosus</i> L.*	Spiny amaranth (E)	Amaranthaceae
8	<i>Amaranthus viridis</i> L.*	Green amaranth (E)	Amaranthaceae
9	<i>Argyrea pomacea</i> Choisy*	-	Convolvulaceae
10	<i>Asteracantha longifolia</i> (L.) Nees.	Hydrophylla (E)	Acanthaceae
11	<i>Basella alba</i> L.*	Indian spinach (E)	Basellaceae
12	<i>Beta vulgaris</i> L.	Beet root, Spinach beet (E)	Chenopodiaceae
13	<i>Boerhavia diffusa</i> L.	Hog weed, Pig weed (E)	Nyctaginaceae
14	<i>Borreria hispida</i> L.*	-	Rubiaceae
15	<i>Canthium parviflorum</i> Lam.*	Emetic nut tree, Wild jasmine (E)	Rubiaceae
16	<i>Cardiospermum halicacabum</i> H.B.K.*	Winter cherry (E)	Sapindaceae
17	<i>Cassia auriculata</i> L.	Tanner's cassia (E)	Fabaceae
18	<i>Cassia occidentalis</i> L.	Tanner's Cassia (E)	Fabaceae
19	<i>Centella asiatica</i> Urban*	Indian pennywort (E)	Umbiliferae
20	<i>Cissus quadrangularis</i> L.	Cissus (E), Piranddai (T)	Vitaceae
21	<i>Coccinia indica</i> L. (=C. grandis Kurz.)	Ivy gourd (E)	Cucurbitaceae
22	<i>Coleus amboinicus</i> Lour.	Countzyborage (E)	Labiatae
23	<i>Cordia obliqua</i> Willd.	Large sebesten (E)	Boraginaceae
24	<i>Cucurbita maxima</i> Duchesne in Lamk.*	Pumpkin (E)	Cucurbitaceae
25	<i>Delonix elata</i> (L.) Gamble.r. Com*	Creamy peacock flower, Yellow	Fabaceae
26	<i>Dregea volubilis</i> (Linn. F.) Hook.f*	Sneez ward (E)	Asclepiadaceae
27	<i>Erythrina variegata</i> L.	Sunshine tree (E)	Fabaceae
28	<i>Gymnema sylvestre</i> (Retz.) R.Br. exchult.*	Gurmar, Gymnema (E)	Asclepiadaceae
29	<i>Ipomea aquatica</i> Forsk.*	Water spinach, Kangkong (E)	Convolvulaceae
30	<i>Ipomoea batatas</i> (L.) Lamb.	Sweet potato (E)	Convolvulaceae
31	<i>Lactuca sativa</i> Linn.*	Lettuce (E)	Asteraceae
32	<i>Lasia spinosa</i> Thw.	Lasia (E)	Araceae
33	<i>Launaea sarmentosa</i> Willd.	-	Asteraceae
34	<i>Leucas zeylanica</i> (L.) R.Br.	Leucas, Ceylon slitwort (E)	Labiatae
35	<i>Manihot esculenta</i> Crantz.	Cassava, Manioc (E)	Euphorbiaceae
36	<i>Mentha arvensis</i> L.	Marsh mint (E)	Labiatae
37	<i>Merremia emarginata</i> Burm f.	Kidney-leaf morning glory (E)	Convolvulaceae
38	<i>Mollugo oppositifolia</i> L.*	Itch flower (E)	Aizoaceae
39	<i>Momordica charantia</i> L.	Bitter melons (E)	Cucurbitaceae
40	<i>Moringa oleifera</i> Lamk*	Moringa, Drumstick (E)	Moringaceae
41	<i>Mukia maderaspatana</i> (L.) M.Roemer.	Madras Pea Pumpkin (E)	Cucurbitaceae
42	<i>Murraya koenigii</i> Spreng*	Curry leaf (E)	Rutaceae
43	<i>Ocimum sanctum</i> L.	Holly basil (E)	Labiatae
44	<i>Oxalis corniculata</i> L.	Indian Sorrel (E)	Oxalidaceae
45	<i>Passiflora edulis</i> Sims.*	Passion (E)	Passifloraceae
46	<i>Pergularia daemia</i> (Forsk.) chiov.	Pergularia (E)	Asclepiadaceae
47	<i>Pisonia grandis</i> R.Br.*	Lettuce tree, Moonlight tree (E),	Nyctaginaceae
48	<i>Premna latifolia</i> Roxb.	-	Verbanaceae
49	<i>Premna obtusifolia</i> R.Br.*	-	Verbanaceae
50	<i>Premna serratifolia</i> L.*	Creek Premna (E)	Verbanaceae
51	<i>Raphanus sativus</i> L.	Raddish (E)	Cruciferae
52	<i>Rivea ornata</i> Choisy*	Midnapore creeper (E)	Convolvulaceae

53	<i>Sauropus androgynus</i> L.*	Sweet leaf, Tropical asparagus (E)	<i>Euphorbiaceae</i>
54	<i>Sesbania grandiflora</i> Pers.*	White dragon tree (E)	<i>Fabaceae</i>
55	<i>Solanum trilobatum</i> L.*	Heliotrope (E)	<i>Solanaceae</i>
56	<i>Solanum nigrum</i> L.	Black night shade, Bush tomato (E)	<i>Solanaceae</i>
57	<i>Trianthema portulacastrum</i> L.	Black pig weed (E)	<i>Aizoaceae</i>
58	<i>Tribulus terrestris</i> L.	-	<i>Zycophyllaceae</i>
59	<i>Trigonella foenum-graecum</i> L.	Fenugreek (E)	<i>Fabaceae</i>

* Available GLVs in the markets.

Market availability of Green Leafy Vegetables (GLVs)

Markets in the Batticaloa district supplied 29 GLVs among the identified species. GLVs that were consumed more than 10% were named as “commonly consumed green leafy vegetables” (CCGLV) (Chandrika *et al.*, 2006) and the GLVs that were consumed less than 10% were named as “rarely consumed leafy vegetables” (RCGLV). Six markets supplied more than 50% of CCGLVs such as Batticaloa, Chenkalady, Eravur, Kaluwanchikudy, Kiran and Oddamavadi (Fig. 3). These places have closer access to the western part of Batticaloa estuary (Fig. 1), where different types of GLVs are cultivated.

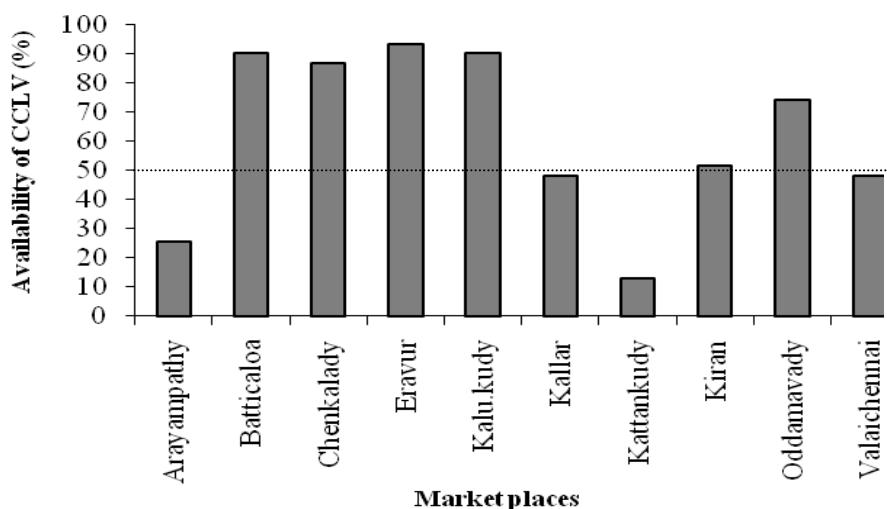


Figure 3. Overall availability of CCGLVs in ten market places.

The mean value of consumption was 57.3%, which was greater than mean value of market availability, 43.7% (Fig. 4). Overall consumption of GLVs is not purely dependant on market availability since GLVs are available from home gardens and elsewhere. The consumption pattern and the availability of RCGLVs was very low when comparing with the CCGLVs. Therefore a detailed comparison was not carried out.

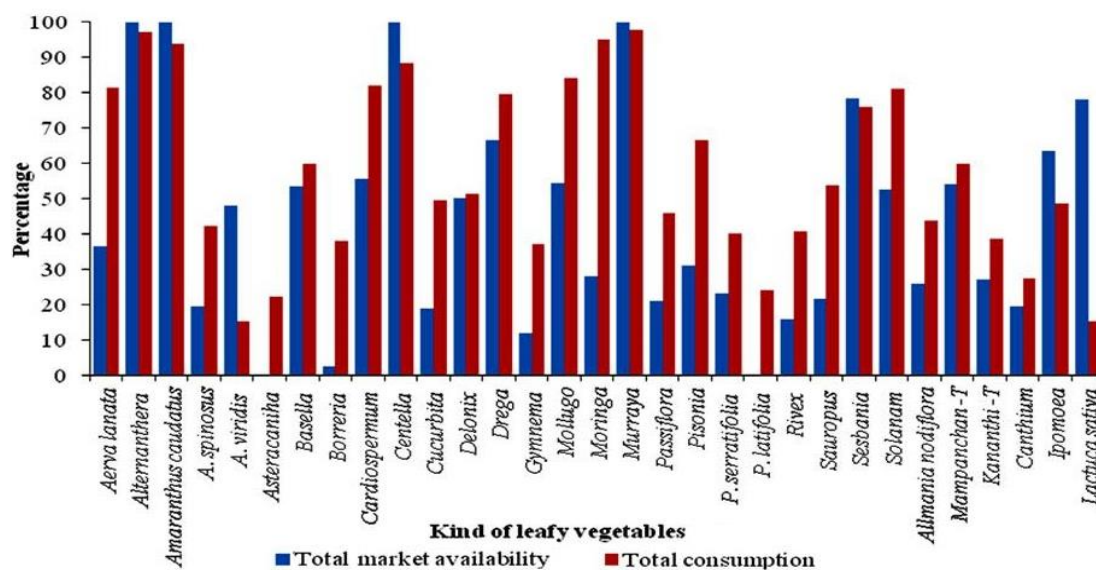


Figure 4. Relationship between availability and consumption pattern of CCGLVs.

Three GLVs were not available generally in the markets in the Batticaloa district such as *A. longifolia*, *B. hispida* and *P. latifolia*, but they were consumed by the people who obtained from elsewhere. At the same time *A. sessilis*, *A. caudatus*, *C. asiatica* and *M. koenigii* were available throughout the year irrespective of the seasons.

Eravur and Kaluwanchikudy markets ranked as first and second places in the availability of GLVs respectively (Table 2). Because those market places have the shortest distance from the supply area and comparatively has higher number of consumers visiting from northern and southern part of the Batticaloa respectively. About 50% of markets such as Kiran, Valaichenai, Kallar, Arayampathy and Oddamavadi showed low availability of the different kinds of GLVs. In those markets, about 25% of GLVs were not available.

Table 2. Comparison of consumption and overall market availability of GLVs.

No.	Market place	Consumption		Market availability	
		Average (%)	Rank	Average (%)	Rank
1	Arayampathy	63.8	5	32.9	7
2	Batticaloa	56.8	7	47.4	4
3	Chenkalady	66.3	3	45.6	5
4	Eravur	44.9	10	75.8	1
5	Kallar	66.1	4	28.8	8
6	Kaluwanchikudy	70.2	1	60.5	2
7	Kattankudy	45.9	9	55.5	3
8	Kiran	68.2	2	25.8	10
9	Oddamavady	53.8	8	40.0	6
10	Valaichenai	57.0	6	27.6	9

People consumed GLVs less frequently in Eravur and Kattankudy compared to other areas (Table 2). But the availability of GLVs in these markets was reasonably higher than the other markets. These two market places are mainly managed by a muslim community and more chances for trade opportunity than markets managed by tamil community, therefore more chances for availability of GLVs.

Kattankudy market is bigger than the adjacent market place in Arayampathy. Distance from Kattankudy to that of the next market (Kaluwanchikudy) is 15 km. Comparatively, more suppliers and consumers visiting Kattankudy market from areas in between the long stretch is more likely. Therefore there are more chances for availability of more varieties of GLVs.

But in the case of Eravur market, the situation is opposite to that of Kattankudy. Even though two other markets are available around Eravur, such as Chenkalady and Kiran at a distance around 2 and 8 km respectively, Eravur market has more suppliers and consumers because it has a long history of existence for more than 60 years, managed by a muslim community and has easy access for suppliers from western part of the Batticaloa estuary.

Consumption of Green Leafy Vegetables

Thirty one species of GLVs (53%), out of the 59 species, were commonly consumed (CCGLVs) in higher amounts. Its average consumption was about 59% and the range was 28-98% (Fig. 5). This is due to market availability, requests by study subjects, size of the market and the distance from the place where the GLVs harvested/supplied. Among the CCGLVs, 13 plant species were consumed less than 50% (Fig. 5). They were *A. nodiflora*, *A. spinosus*, *A. longifolia*, *B. hispida*, *C. parviflorum*, *G. sylvestre*, *I. aquatica*, *L. sativa*, *P. edulis*, *P. serratifolia*, *P. latifolia*, *R. ornata* and *P. obtusifolia*. This is mainly due to seasonal availability (Puspamma *et al.*, 1984) and requests by the study subjects.

Twenty eight species were rarely consumed (RCGLVs) and its average consumption was 1.6% and the range was 0.1-6% (Fig. 6). These GLVs are not grown in larger scale and less known by the subjects.

Consumption of GLVs in cooked and uncooked state

GLVs were consumed in cooked and uncooked forms. Ninety seven percent of CCLVs (30 species) were eaten in the cooked form. Sixty eight percent of CCLVs (21 species) were eaten in the uncooked form. More than 50% of people consumed *C. asiatica* and *S. trilobatum* in uncooked form. *L. sativa* was the only GLV consumed in uncooked form. *A. caudatus*, *A. viridis*, *B. alba* and *M. oppositifolia* were consumed only in the cooked form. These results showed that people used these leafy vegetables in a traditional form of preparation (cooking) due to taste and palatability. RCLVs were consumed mostly (93%) in the cooked form. Fifteen

percent of them were consumed in uncooked form such as *C. amboinicus*, *M. charantia*, *O. tenuiflorum*, *T. terrestris* and *L. spinosa*.

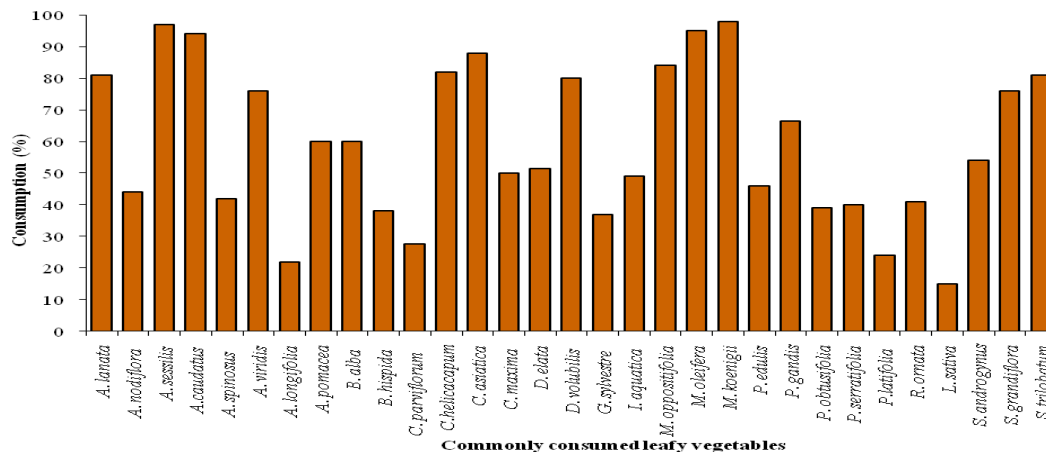


Figure 5. Consumption pattern of CCGLVs.

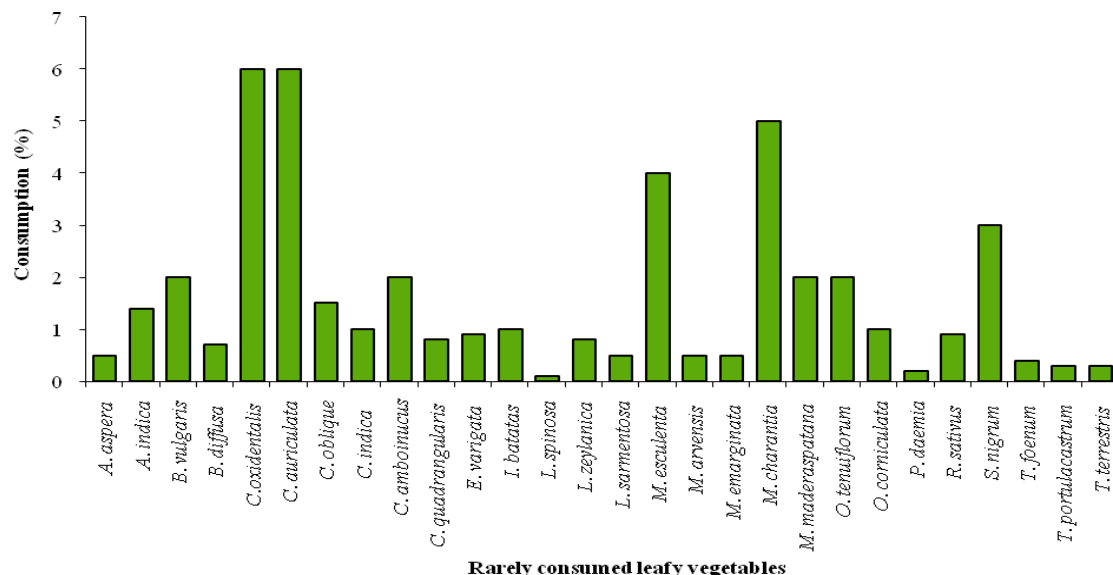


Figure 6. Consumption pattern of RCGLVs.

Frequency of consumption of GLVs

The weekly frequency of consumption ranged from 1–7 days. Monthly frequency ranged from 1–3 days. Annual frequency was less than 12 days. For an example, 90% of the study subjects interviewed stated that they consumed *A. caudatus* every week and 7% indicated they consumed less than 3 days/month. The average consumption of CCGLVs was 31% on weekly, 28% on monthly and 0.2% on annual basis. *A. sessilis*, *A. caudatus*, *C. asiatica*, *D. volubilis*, *M. oppositifolia*, *M. oleifera*, *M. koenigii* and *S. trilobatum* were consumed by 50% or more of the study subjects interviewed every week. These GLVs were generally available throughout the year. Some of them were cultivated in the home garden. *A. sessilis*, *A. caudatus* and *C. asiatica* and *M. oleifera* were generally available in most of the home gardens and less available in markets. *D. volubilis* is available most of the time in forestland, open bare lands and fences. These plants are less affected by seasons.

More than 50% of individuals interviewed in Chenkalady, Kaluwanchikudy and Kiran indicated they consumed GLVs daily (Fig. 7). This is due to availability of GLVs in the market as well as elsewhere. The highest percentage of daily intake of leafy vegetables was recorded at Kiran (88%) and the lowest at Oddamavadi (19%).

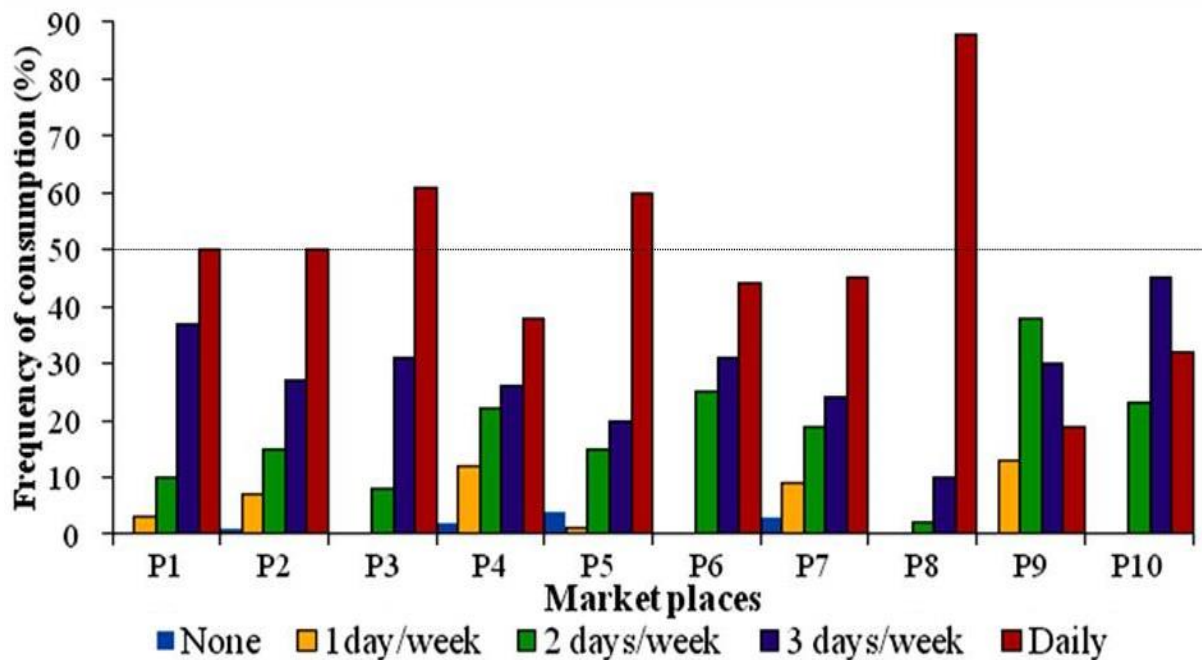


Figure 7. Frequency of consumption of GLVs at different study sites, in a week time: **P1**, Arayampathy; **P2**, Batticaloa; **P3**, Chenkalady; **P4**, Eravur; **P5**, Kallady; **P6**, Kallar; **P7**, Kattankudy; **P8**, Kiran; **P9**, Oddamavady; **P10**, Valaichenai.

The overall consumption of GLVs recorded was 48.7% on daily basis and 1% for more than 3 days per week. Praba *et al.*, (2009) found 51% of respondents consumed greens twice a week among selected households at Bangalore, India. Furthermore overall consumption of GLVs twice a week ranged from 8% to 38% and three times per week ranged from 10% to 45% (Fig. 7).

Storage of green leafy vegetables

GLVs remaining after cooking were stored by most of the people but it was not a regular practice. There were two main storage methods practiced such as keeping at low temperature (refrigeration, at 4°C) and at room temperature (30±2°C). Refrigeration of the GLVs was the commonest (65%) method (Sankat and Maharaj, 1996) of storage and 23% preferred room temperature to store. About 11% used other techniques such as wrapping in polythene bags and leaving at room temperature, keeping washed GLVs open outside the houses at night and wrapping in banana leaves and 17% did not answer this question. The percentage of answer “none” was higher in Kiran (73%) followed by Batticaloa (22%) and Arayampathy (10%) (Fig.8). These results show that people prefer fresh GLVs for consumption. Packaging of leafy vegetable was very effective in reducing weight and moisture losses during storage, retarding chlorophyll degradation and loss of odour and maintaining stability (Ahvenainen, 1996).

In Chenkalady, Kaluwanchikudy and Valaichenai higher percentage of subjects stored GLVs at room temperature compared with other places. In Kaluwanchikudy higher percentage of subjects used other techniques. But these storage methods are not significantly practiced most of the times.

In Kiran, 100% of consumers preferred consumption of GLVs without storage (Fig. 8). But interviews revealed that if they do not consume on the day of purchase they stored the GLVs. But in other places, consumers normally purchase or harvest GLVs for immediate consumption as well as for storage.

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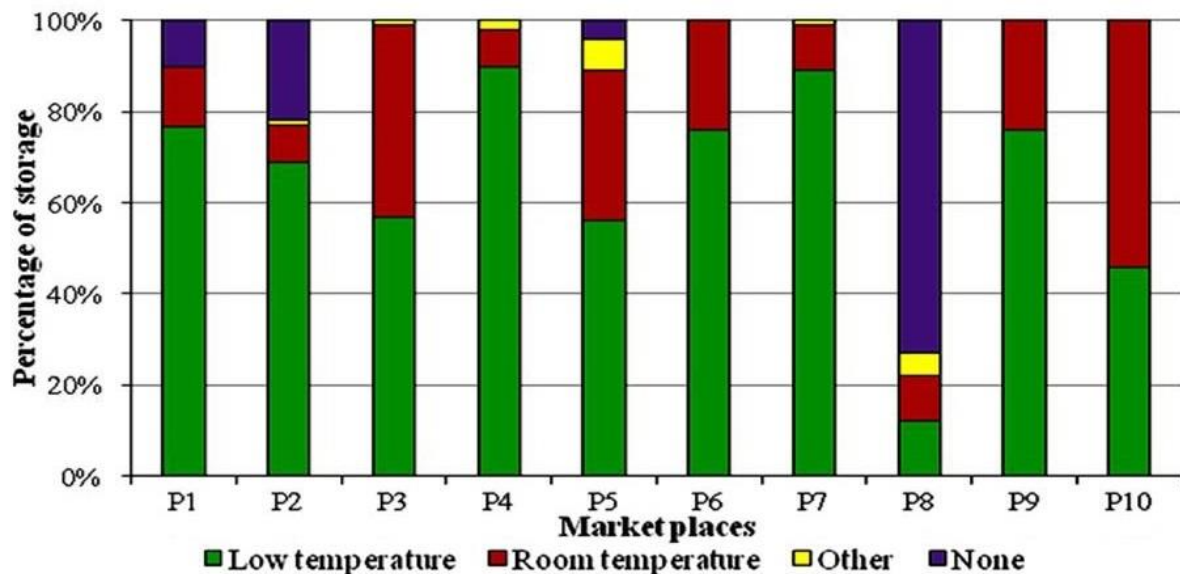


Figure 8. Storage of GLVs after purchase in different study sites: **P1**, Arayampathy; **P2**, Batticaloa; **P3**, Chenkalady; **P4**, Eravur; **P5**, Kallady; **P6**, Kallar; **P7**, Kattankudy; **P8**, Kiran; **P9**, Oddamavady; **P10**, Valaichenai.

CONCLUSION

Fifty nine species were identified as sources of GLVs in the Batticaloa district of which 29 species were available in the markets. Other species were obtained from home gardens, river sides and forest lands. Seasonality, market size and easy access of supply area to market determined the availability of GLVs. Attitude of people, food habit and level of awareness on GLVs also contributed to the availability of GLVs.

Thirty one species of GLVs were consumed in higher amount (average consumption of 59% - commonly consumed leafy vegetables-CCLVs) and 28 species were consumed in lower amount (average consumption of 1.6% - rarely consumed leafy vegetables-RCLVs). GLVs were consumed in cooked and uncooked states. Higher percentage of CCLVs was consumed on weekly basis both by the subjects (31%). Majority of the subjects prefer to consume the GLVs immediately after harvesting/purchasing. Excess GLVs were mainly stored at room temperature and in refrigerator.

ACKNOWLEDGEMENTS

We thank Mr. T. Kugathan Technical Officer, Department of Botany, Eastern University, Sri Lanka to provide technical assistance for conducting the field work. Our gratitude goes to leafy vegetable sellers and local people who involved during our survey. Our appreciation goes to Dr. D.S.A.Wijesundara, Director General/Department of National Botanical Gardens, Peradeniya, Sri Lanka to facilitate us to identify some of the leafy vegetables.

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