

Survey and Conservation of Indigenous Fruits of Western Ghats

Prakash Chandra Tripathi, Ganesan Karunkaran, Vadivel Sankar and Rathnam Senthil Kumar

Central Horticultural Experiment Station (IHHR), Chettalli-571 248, Kodagu, Karnataka, India

Abstract: Western Ghats region of India is one of the biodiversity hotspots of the world. The topography, wide rainfall variation and varied temperature conditions enable inhabitancy of several plant species. This plant wealth is being used in various forms by tribes and natives of the area for centuries. These gain further importance due to the fact that ripe fruits serve as a source of food and medicine to tribes throughout the year. These wild fruits are source of minerals and vitamins in the diet of the rural people. The potential productivity and floristic diversity of the area have attracted the experts. There are more than 50 wild edible fruit species are available in Western Ghats region. These belong to 25 families and 38 genera. Out of the 25 families, the important ones as a source of fruits are *Apocynaceae*, *Anacardiaceae*, *Euphorbiaceae*, *Moraceae*, *Sapotaceae* and *Sapindaceae*. The fruiting period of different species ranges between two and six months. The highest number of species mature from April to May. The availability of these fruits reduces after October. Some of these fruits, such as *Mangifera indica*, *Artocarpus heterophyllus*, *Carissa carandas*, *Emblica officinalis* and *Syzygium cumini*, have been given emphasis in order to identify high yield and high fruit quality clones and standardization of production technologies. The collection, conservation and utilization on some of the fruits, such as *Garcinia indica* and *Garcinia gummigutta* have started at various research organizations. Some other fruits, namely *Chrysophyllum roxburghii* (Family Sapotaceae), *Canthium parviflora* Lamk syn. *Plectronia parviflora* (Lam.) Bedd. (Family Rubiaceae), *Elaeagnus conferta* Roxb. syn. *Elaeagnus latifolia* L. (Family Elaeagnaceae), *Securina leucopyrus* syn. *Flueggea leucopyrus* (Family Euphorbiaceae), *Elaeocarpus tuberculatus* Roxb. (Family Elaeocarpaceae), *Nephelium stipulacum* Bedd. syn. *Doratoxylon stipulatum* (Family Sapindaceae) have potential for commercial cultivation. Thus, attempts were made with the objective of recording availability of these species, proximate analysis and their on farm and off farm conservation at Central Horticultural Experiment Station (CHES). Few plants were also provided to local growers on farm conservation. The continuous depletion of forest and the increasing human disturbance resulted in losses of these species. There is need to conserve these fruits for future.

Key words: Western Ghats, indigenous fruits, genetic variability, conservation.

1. Introduction

India is endowed with a rich genetic diversity of tropical fruits. The Western Ghats region of Indian subcontinent is very rich in diverse edible fruit yielding plant species. The Western Ghats hills lay in the East Coast of Arabian seas and spread in six Indian states, namely Gujarat, Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala in a stretch of 1,600 km long and 40-60 km wide from North to South. The region has several mountain peaks, which hinder monsoon winds resulting in heavy rainfall in this region. The heavy rainfall and different

temperature conditions allow several plant species inhabiting the region [1]. The area is one of the biodiversity hotspots of the world and is home for 7,402 species of flowering plants, 1,814 species of non-flowering plants; it is likely that many undiscovered species live in the Western Ghats [2]. Many of them yield edible fruits and vegetables. This plant wealth is being used in various forms only by tribal and natives population of the area.

Genetic resources of native fruits of Western Ghats have not been paid enough attention due to their comparatively less commercial importance and limited research. These crops are well adapted to degraded, arid and semi-arid ecosystems having high potential for mitigating inevitable climate change

Corresponding author: Prakash Chandra Tripathi, Ph.D., research fields: tropical underutilized fruits and citrus improvement.

scenario, and hence need immediate attention. Uthaiiah [3] reported 50 species wild edible fruits in the Coorg region of Western Ghats. These belong to 38 genera, 25 families, but the number of species is estimated higher since there are species not yet identified. Khaple et al. [4] studied the status of wild edible fruit tree species in two vegetation types of Kodagu and found that species richness, diversity of wild edible tree species and families were higher in evergreen vegetation. Deshmukh and Waghmode [5] reported that 11 fruit plant species were investigated for their nutritional food value and medicine from Western Ghats region of Maharashtra. The fruits are rich in sodium, potassium, magnesium, iron, calcium, phosphorus, etc.. Sasi and Rajendran [6] reported 70 wild and less known plants species belonging to 48 genera of 27 families of the Nilgiri region which have ethnobotanical importance. Sathyavathi and Janardhanan [7] listed 30 wild plant species yielding edible fruits used by the Badagas tribe in the Nilgiri district for their conservation and cultivation purposes. Yesodhoran and Sujana [8] reported 71 species used by the tribal populations of Parambikulam wild life

sanctuary, Kerala. Out of these 71 species, 30 species are used as leafy vegetables and 31 species are used as fruits. The seeds of 16 species are used for food or feed purposes, while roots or tubers of 10 species are also used. Studies on the nutritional compositions of six fruits of Western Ghats revealed that higher level of anthocyanin, ascorbic acid total phenols and flavonoids were found in methanol extracts of *Mahonia leschenaultii*, *Gaultheria fragrantissima* and *Rubus ellipticus* [9].

In recent years, the available of these fruits has decreased due to change in land use pattern, human disturbance and unsustainable exploitation. Thus, effort attempts were made with the objective of recording availability of these species, proximate analysis and their on farm and off farm conservation.

2. Materials and Methods

The wild edible fruits of Western Ghats were recorded with random survey method in Kodagu, Dakshin Kannada districts of Karnataka and Waynad district of Kerala, India, during 2012 and 2014 (Fig. 1). Data on plant attributes, local and vernacular names,

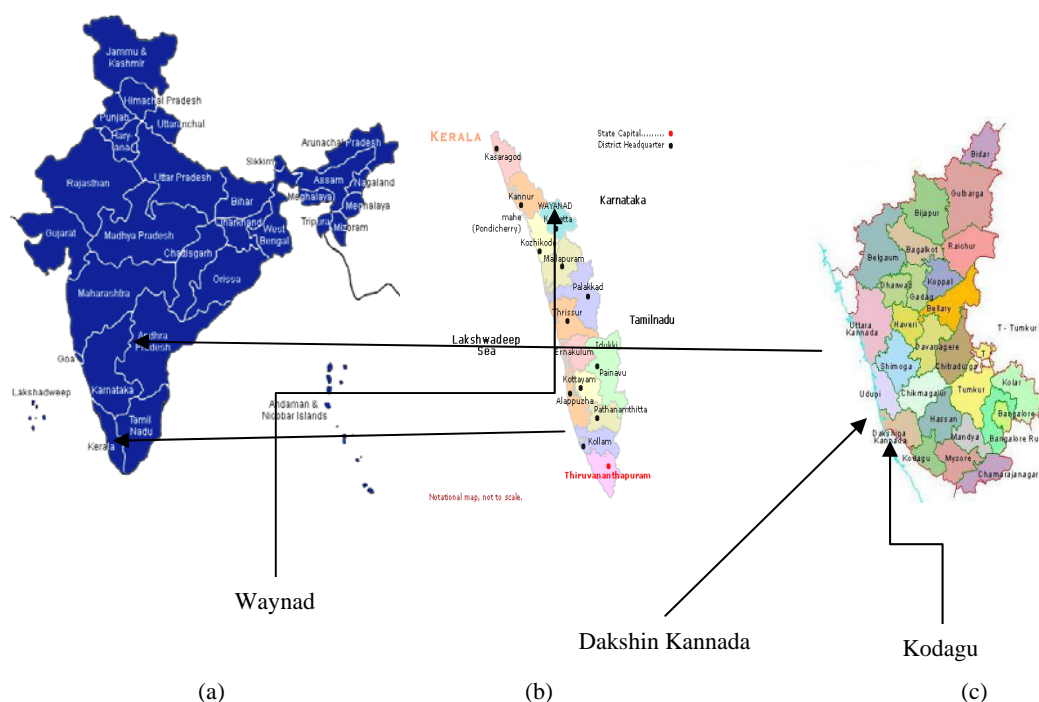


Fig. 1 Study area map.

a: India map, b: showing Waynad district in Kerala, India and c: showing Dakshin Kannada and Kodagu districts in Karnataka, India.

phenology and propagation methods, flowering and fruiting time, fruit utility and consumption and taste were collected from surveyed areas. Total 25 surveys were made, and respondents included planters, managers, laborers, local people and traders participated in interviews. The taxonomical data available from different sources, particularly flora of Coorg [10], were used to identify the plant species. The fruits and seeds of some of the species were collected and analyzed at CHES, Chettalli for various fruits quality characters, i.e., fruits weight, fruit volume, total soluble solids (TSS) and titrable acidity using standard methods of Ranganna [11]. The seeds and plantlets of some of these species were collected from forests and plantations, and seedlings were raised. The seedlings were planted at the research farm for future evaluation. Many saplings were distributed to the selected planters to conserve the biodiversity of these species.

3. Results and Discussion

There are more than 50 wild edible fruit species available in Western Ghats region. Some of the species, such as *Mangifera indica*, *Artocarpus heterophyllus*, *Carissa carandas*, *Emblia officinalis* and *Syzygium cumini*, have been commercialized and extensively grown in various areas of the country. There are several other plant species which are used by the tribal and local people (Table 1). These wild edible fruits of Western Ghats region belong to 25 families. The highest number of wild fruit species belongs to Family Euphorbiaceae (four species), Sapindaceae (three species), Elaeagnaceae (three species), Clusiaceae (three species), Myrtaceae (three species) and Moraceae (two species). Out of 38 species observed and collected, 28 species are trees, seven are woody shrubs and three are woody climbers. All these species are perennial. Most of them are found in both deciduous and moist forests. Some of the species, i.e., *Garcinia xanthochymus*, *Garcinia indica*, *Garcinia Gummigutta*, *Artocarpus heterophyllus*, *Artocarpus*

hirsutus, *Syzygium cumini* and *Chrysophyllum roxburghii*, are also found grown in coffee and other plantation areas as shade trees or as border trees. Some of them, namely *Canthium dicoccum* var. *umbellatum*, *Carissa gangetica*, *Epiprinus mallotiformis*, *Garcinia gummigutta*, *Glycosmis mauritiana*, *Nephaliu stipulacum* and *Salacia malabarica*, are exclusively found in higher elevation (1,400-1,700 m). Regarding fruit maturity, at least six plant species produce fruits each month of the year. The fruiting period of different species ranges between two and six months. Most of the species have fruit maturity between April and May. The availability of these fruits reduces after October. Most of these fruit bearing species (34 species) produce fruits that are used as fresh fruits; fruits of four species are used as fresh fruits and for picking purpose as well as candy preparation. In most of the fruits, pericarp and mesocarp are edible. In few species, aril is edible portion. Two species, namely *Garcinia indica* and *Garcinia gummigutta* produce fruit that are not used as fresh fruits, but their rind is dried and used as souring agents after drying. The fruits of these two species are also used for preparation of syrup and vinegar. These are good source of hydroxy citric acid, garcinol and xanthones used in anti-obesity formulations [12]. *Garcinia xanthochymus* is used as fresh fruit and souring agent. The seed kernel of two species is used as feed and/or food purposes, while seed kernel of three *Garcinia* species is used to extract butter. Some of tree species, namely jack fruit *Artocarpus hirsutus*, *Syzygium cumini* and *Chrysophyllum roxburghii*, are also used as timber. Some fruit species, i.e., *Syzygium cumini*, *Carissa carandas*, *Carissa gigatica* and *Emblia officinalis* are also used for wine preparation. The species of medicinal importance are *Chrysophyllum roxburghii*, *Carissa carandas*, *Carissa gigatica*, *Emblia officinalis*, *Garcinia gummigutta* and *Syzygium cumini*.

Most of the species are small fruits, only few species, namely jack fruit *Artocarpus hirsutus*, *Syzygium cumini*,

Table 1 Wild edible fruits of Western Ghats region.

Botanical name	Family	Plant type	Fruiting season	Use	Occurrence area
<i>Allophylus serratus</i> (Roxb.) Kurz	Sapindaceae	Shrub to small tree	February-April	Consumed in fresh stage	Degraded forest
<i>Aporosa lindleyana</i> (Wight) Baill	Euphorbiaceae	Medium tree	May-July	Consumed in fresh stage	All over the area
<i>Artocarpus hirsutus</i> Lam.	Moraceae	Tree	May-June	Ripe carpels are consumed fresh, tender fruit used in pickling, seed roasted and consumed	All over the area
<i>Artocarpus lacucha</i> Buch-Ham.	Moraceae	Tree	November-January	Picking, souring agent, pulp is consumed in fresh state	Not common, all over the area
<i>Borassus flabellifer</i> L.	Palmae	Tree	December-April	Consumed in fresh form	Western slopes at lower elevation
<i>Canthium dicoccum</i> var. <i>umbellatum</i> (Wight) Santapau & Merchant	Rubiaceae	Tree	April-June	Fresh fruits are consumed in ripe stage	Higher elevation
<i>Canthium parviflora</i> Lam. syn. <i>Plectronia parviflora</i> (Lam.) Bedd.	Rubiaceae	Tree	April-June	Fresh fruits are consumed in ripe stage	All over the region
<i>Chrysophyllum roxburghii</i> G. Don	Sapotaceae	Tree	March-May	Ripe fruits are consumed when fresh	Rarely, only in reserve forest area
<i>Carissa carandas</i> L.	Apocynaceae	Shrub	April-May	Fruits are used as fresh, pickling, jams, sun dried and preserved	Lower elevation
<i>Carissa gangetica</i> Stapt	Apocynaceae	Shrub	June-August	Fruits are used as fresh, pickling, jams, sun dried and preserved	Higher elevation
<i>Cordia dichotoma</i> G. Forst.	Cordiaceae	Small tree	December-February	Ripe fruits are eaten	Rare
<i>Elaeagnus conferta</i> Roxb.	Elaeagnaceae	Thorny climbers	January-March	Ripe fruits are consumed	Not commonly noticed
<i>Elaeocarpus tuberculatus</i> Roxb.	Elaeocarpaceae	Tall tree	September-November	Ripe fruit, kernels	Not commonly encountered
<i>Elaeocarpus munronii</i> (Wt.) Mast.	Elaeocarpaceae	Tree	March-April	Ripe fruits are consumed	Not common
<i>Epiprinus mallotiformis</i> (Mueller)	Euphorbiaceae	Tree	April-June	Ripe fruits are consumed	Commonly found at higher elevation
<i>Flacourtia indica</i> (Burm. f.) Merr.	Flacourtiaceae	Small tree	August-October	Ripe fruits are consumed	Scattered all over the region
<i>Flacourtia montana</i> Graham	Flacourtiaceae	Small tree	December-February	Ripe fruits are consumed	Not common but occur all over the region
<i>Garcinia indica</i> (Du Petit-Thou.) Choisy	Clusiaceae	Tree	March-May	Used in preparing soft drinks and souring agent	Western side of Ghats at low elevation
<i>Garcinia gummi-gutta</i> (L.) Roxb.	Clusiaceae	Tree	August-October	Dried rind and concentrated juice used as souring agent	Higher elevation
<i>Garcinia xanthochymus</i> Hook. f. ex T. Anders.	Clusiaceae	Tree	December-March	Consumed when ripe, dried rind used as souring agent	Not common but found all over the region
<i>Glycosmis mauritiana</i> (Lam.) Tanaka	Rutaceae	Small tree	December-February	Consumed at ripe stage	Degraded forest at higher elevation

(Table 1 continued)

Botanical name	Family	Plant type	Fruiting season	Use	Occurrence area
<i>Grewia tiliifolia</i> Vahl	Tiliaceae	Tree	May-June	Consumed at ripe stage	All over the region
<i>Margaritaria indica</i> (Dalz.)	Euphorbiaceae	Tree	September-November	Consumed at ripe stage	Rarely noticed
<i>Dimocarpus longan</i> Lour.	Sapindaceae	Tree	August-November	Aril only consumed	Not commonly found
<i>Nephelium stipulacum</i> Bedd.	Sapindaceae	Tree	July-September	The arils of the fruit only eaten	Rarely noticed occur at higher elevation
<i>Rourea minor</i> (Gaertn.)	Connaraceae	Woody climbing shrub	June-August	Consumed at ripe stage	Rarely found
<i>Rubus ellipticus</i> J.E. Sm.	Rosaceae	Shrub	February-April	Consumed at ripe stage	Common along the banks of streams and marshy areas
<i>Salacia malabarica</i> Gamb	Hippocrateaceae	Climber	June-July	Consumed at ripe stage	Rarely found only at higher elevation
<i>Scutia circumscissa</i> Druce	Rhamnaceae	Shrub	June-August	Consumed at ripe stage	Common in the forest area of the region
<i>Flueggea leucopyrus</i> Willd.	Euphorbiaceae	Shrub	June-July	Consumed at ripe stage	Rare
<i>Symplocos cochinchinensis</i> (Lour.)	Symplocaceae	Tree	September-November	Consumed at ripe stage	Found all over the region
<i>Syzygium cumini</i> L. (Skeels)	Myrtaceae	Tree	April-June	Consumed at ripe stage	Found all over the region
<i>Syzygium gardneri</i> Thw.	Myrtaceae	Tree	January-March	Consumed at ripe stage	Found all over the region
<i>Syzygium jambos</i> L. (Alston)	Myrtaceae	Tree	November-January	Consumed at ripe stage	Rare found all over the region
<i>Terminalia bellerica</i> (Gaertn.) Roxb.	Combretaceae	Tree	January-April	Matured kernel is consumed	Found all over the region
<i>Xeromphis spinosa</i> (Thub.) Keay	Rubiaceae	Small tree	June-July	Consumed at ripe stage	Common all over the region
<i>Zizyphus oenoplia</i> L.	Rhamnaceae	Shrub	December-January	Consumed at ripe stage	Common in scrub jungle
<i>Zizyphus rugosa</i> Lam.	Rhamnaceae	Small tree	February-March	Consumed at ripe stage	Degraded forest areas

Table 2 Fruit characteristics of some wild fruits.

Botanical name	Fruit weight (g)	Fruit volume (mL)	Fruit length (cm)	Fruit breadth (cm)	Rind color	Flesh color	TSS (°Brix)	Acidity (%)	No. of seeds
<i>Averhoa bilimbi</i> L.	15.60	16.00	5.60	2.20	Green	White	5.20	-	-
<i>Artocarpus lacucha</i> Buch-Ham.	113.50	115.20	6.10	6.30	Green	White	6.70	-	-
<i>Artocarpus hirsutus</i> Lam.	93.55	95.00	6.45	5.30	Dull yellow	Light yellow		-	12.50
<i>Securina leucopyrus</i> Brandis	9.33	9.51	2.34	2.47	Whitish green	White	15.60	-	2.17
<i>Cordia dichotoma</i> G. Forst.	3.11	3.20	1.27	1.61	Whitish pink	White	16.30	-	31.00
<i>Chrysophyllum roxburghii</i> G. Don	54.53	54.80	4.24	4.86	Green	White	22.00	-	3.00
<i>Carrissa carendus</i> L.	9.04	9.15	2.53	2.46	Violet	White	15.20	-	2.30
<i>Syzygium cumini</i> L. (Skeels)	2.12	2.20	1.51	1.10	Violet	Reddish	11.20	-	1.00
<i>Rubus niveus</i> Thunb.	1.50	1.80	1.10	1.20	Black	Reddish	13.20	-	37.00
<i>Garcinia indica</i> (Du Petit-Thou) Choiss	52.63	51.80	4.15	4.86	Dull red	Red rind	14.78	4.16	5.13
<i>Garcinia gummi-gata</i> (L.) Roxb.	60.30	56.10	5.20	5.10	Dull yellow	Yellow rind	8.90	-	5.20
<i>Garcinia xanthochymus</i> Hook. f. ex. T. Anders.	127.78	127.80	6.64	6.15	Bright yellow	Yellow	12.70	7.20	1.40
<i>Citrus aurantifolia</i> (Christm.) Swingle	28.20	29.00	-	-	Yellow	White	7.20	-	-
<i>Citrus reshni</i> var. <i>kodakithuli</i> Tanaka	18.37	18.20	2.64	3.49	Bright orange	Orange	11.20	0.46	8.00
<i>Citrus maderaspatna</i> Tanaka	15.20	15.50	2.63	3.51	Bright orange	Orange	13.20	0.21	9.00

Chrysophyllum roxburghii, *Garcinia indica*, *Garcinia xanthochymus* and *Garcinia gummigutta* have bigger fruits. Among the species analyzed, the highest weight were recorded in *Garcinia xanthochymus* (127.78 g), followed by *Artocarpus lacucha* (113.5 g) and *Artocarpus hirsutus* (93.55 g). The fruit weight was more than 50 g in *Garcinia gummi-gutta* (60.30 g), *Chrysophyllum roxburghii* (54.53 g) and *Garcinia indica* (52.63 g). The shape of fruit was globe to oblong in most of the fruits, while it was cylindrical in *Averhoa blimbi*. There is large variability in fruit colour. It ranged from bright red, yellow and violet to black and green. Regarding TSS, the highest proportion was found in *Chrysophyllum roxburghii* (22.0° Brix), followed by *Cordia dictoma* (16.3° Brix), *Securina leucopyrus* (15.6° Brix) and *Carissa carandus* (15.6° Brix). Most of these fruits are acidic in taste. The highest titrable acidity was found in *Garcinia xanthochymus* (7.2%) (Table 2). Regarding the nutritional value, Karuppuswamy et al. [9] revealed that these fruits are rich in vitamins and minerals. Due to the nutritional value, these fruits are diet components of local tribes long ago.

In recent years, a large variety of trees, shrubs, creepers, lianas, scrubs and herbs were felled due to conversion of native forest to cultivation crops. This has resulted in loss of wild native trees, important component of which are trees that produce edible fruit. Uthaiiah [3] reported large populations of wild fruit-producing trees in the region in early to mid 1990s. Many wild fruit trees had been felled due to changes in land use. During survey, it was reported by many respondents that these fruits were abundant in forests and village few decades ago, though now are rarely seen. All of the opinions were that these fruits should be conserved. Accordingly, 12 species were planted for conservation. Although most of these species are now endangered, some of them are still found in forest reserves and selective sites. All the respondents emphasized the need for conservation of these species for future.

4. Conclusions

The wild edible fruit species of the Western Ghats region serve as important component of the ecosystem of the area. Due to changes in land use, many of these valuable species are being removed and there is an urgent need to conserve these valuable wild plants. The collection, conservation and utilization efforts for some species, such as *Garcinia indica* and *Garcinia gummigutta*, have started at various research organizations. Fruits of some other species, namely *Chrysophyllum roxburghii* (Family Sapotaceae), *Canthium parviflora* Lamk syn. *Plectronia parviflora* (Lam.) Bedd. (Family Rubiaceae), *Elaeagnus conferta* Roxb. syn. *Elaeagnus latifolia* L. (Family Elaeagnaceae), *Securina leucopyrus* syn. *Flueggea leucopyrus* (Family Euphorbiaceae), *Elaeocarpus tuberculatus* Roxb. (Family Elaeocarpaceae) and *Nephelium stipulacum* Bedd. syn. *Doratoxylon stipulatum* (Family sapindaceae), have a potential for commercial cultivation. Studies on their nutritional and pharmaceutical importance, and efforts towards multiplication for value assessment for economical values attribution to the fruit products will contribute to cultivation of such species.

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