

UNEXPLOITED AND UNDERUTILIZED WILD EDIBLE FRUITS OF WESTERN GHATS IN SOUTHERN INDIA

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Abstract

Fruits play predominant role in the diet. Several health based statistical reports highlight the importance of consumption of fruits as they tend to contain broad-spectrum essential nutrients including phenolic antioxidants that impart protective role against several diseases. Western Ghats, one among eight “hottest hot-spots” of biodiversity in world harbor many wild, unexploited and minor fruits which are edible and unfamiliar to large proportion of the global population. Wild edible fruits are important source of food and income for rural communities. Wild fruits are therapeutic in nature and used to treat wide array of diseases including chronic diseases. In the last three decades, increased urbanization and deforestation for agricultural land use has led to destruction of valuable plant species including fruit yielding plants. As a result, substantial decrease in the consumption and utilization of wild edible fruits has been noticed. The present article describes 45 fruits that are edible and prominent in the Western Ghats region of Southern India. Detailed information on nutrient composition of these minor fruits is provided, as consumed by tribal and rural communities.

Key words: minerals, nutritional composition, South India, Western Ghats, Wild edible fruits.

INTRODUCTION

India is one of the mega diversity tropical countries that comprise rich vegetation and biodiversity. The Western Ghats is one such hotspot which is home to many wild, unutilized, underutilized and minor fruits that are rarely eaten and still many are unfamiliar to the major population. Since, these wild edible fruits comprise broad-spectrum essential nutrients, vitamins and secondary metabolites they can be considered for cultivation, consumption and utilization. However, these wild fruits may not taste good unlike cultivated tropical fruits but they hold good proportions of antioxidants, essential nutrients and bioactive molecules. Moreover, many wild fruits serve as possible future source of income for local communities in rural areas of several developing and poorly developed nations. Over the past few years, the information related to wild fruits is endangered. Due to lack of suitable and efficient processing techniques and increased deforestation has resulted in extinction of many of these fruit bearing wild plants from their natural vegetation.

Furthermore, deprived knowledge about wild fruit identification to utilization and from harvesting to processing is another major hurdle to overcome. Also, studies on nutritional attributes of these wild fruits are not properly documented. Hence, cultivation, promotion and conservation of these wild edible fruits are very crucial for nutritional, medicinal and economic purposes. Though these crops grow in wild and have been neglected, they have their own unique properties, such as nutritional and therapeutic values. Hence, there is enormous scope to these fruits by creating awareness among the locals and popularization of value added products from these fruits. Wild fruits are available in plenty in their natural habitats; still it is relatively essential to have their germplasm conserved. Subsequently, this may help in tackling the problems arising due to urbanization and geographical variations.

BIODIVERSITY AND BIORESOURCES OF WESTERN GHATS

During the past few decades several studies have indicated that the Western Ghats harbor

several important plants. The availability of rich bioresources is now being utilized in producing several important value added products that are commercially exploited in food, agriculture, medicine and cosmetic industries. Moreover, several wild edible fruits tend to be nutritious and medicinal. It is remarkable to mention that in a year, not less than six to eight plant species will be in fruiting in each month and majority of these wild edible fruits belong to *Anacardiaceae*, *Apocynaceae*, *Euphorbiaceae*, *Moraceae* and *Sapotaceae* families (Uthaiyah, 1994). There are more than 60 wild edible fruits available in entire Western Ghats region. More recently, Jadhav et al. (2015) reported 159 wild edible plants from the Northern Western Ghats of Maharashtra, of which 77 fruit bearing plant species are edible and most fruits are consumed during January-July. According to Kumar and Shiddamallayya (2016), forest region of Hassan district of Southern Western Ghats has 75 wild edible fruit species belonging to 40 families and 60 genera. Nazarudeen (2010) studied the nutritional composition of wild fruits such as *Alangium salvifolium*, *Antidesma ghaesembilla*, *Baccaurea courtallensis*, *Debregeasia longifolia*, *Palaquium ellipticum* and *Tamilnadia uliginosa*. Several ethnobotanical studies indicated that though these fruits are not so tasty and desirable unlike cultivated fruits, nevertheless, these wild edible fruits are rich in nutritional content with respect to protein, fat and iron content. Among the wide range of available edible wild plant species, wild fruits are foremost provider of subsidiary nutrition to the rural communities. Generally, native plants determine the dietary habits of ethnic communities, though they are not nutrition specific in most occasions. Therefore, it can be concluded that the wild edible fruits are more superior to cultivated fruits when nutrition is taken in to account (Valvi et al., 2011). However, it is essential to mention that due to increased urbanization and deforestation several plant species are endangered and are under the threat of extinction. Recent studies reveal that during 1920 to 2013 as much as 35.3% of forest cover in the Western Ghats has been changed or disturbed (Reddy et al., 2016). Hence, as a foremost priority, the bioresources

including wild edible fruits of Western Ghats has to be preserved and conserved (Deshmukh and Shinde, 2010; Hebbar et al., 2010; Narayanan et al., 2011; Harisha and Padmavathy, 2013).

WILD EDIBLE FRUITS OF WESTERN GHATS

The present article describes some of the important wild fruits of the Western Ghats, particularly in Southern India. A list of 45 fruits has been listed out that are edible, but the list is by no means complete. Information is provided for the rare fruits that are consumed by the tribal and rural communities. Although people consume these fruits freshly, in certain occasions the juice is taken out from the rind, rind is sundried and used as a souring agent as spice for the preparation of beverages and typical south Indian cuisines. Seeds of some *Clusiaceae* members such as *Garcinia indica* and *Garcinia gummi-gutta* yield high oil, which is known to comprise potential therapeutic properties. Commercially, butter extracted from these fruits are used for producing cosmetics and functional foods, however, traditionally these fruits are utilized for esculent, medicinal and cosmetic purposes.

FLOWERING/FRUITING PHENOLOGY AND NUTRITIONAL POTENTIAL OF WILD EDIBLE FRUITS

Aporosa cardiosperma (Gaertn.) Merr. is a valuable medicinal tree endemic to Sri Lanka, often several parts of plant such as leaves, roots and stems are utilized as a ethnomedicine against several health ailments including fever, skin diseases, diabetes, infertility and hepatic diseases.

Fruit description: Fruits globose or ovoid, pointed with the persistent style, 10-14 mm across, thin-walled, smooth, fruiting pedicels 5-6 mm long; suborbicular seeds, the edible part is yellow transparent arils comprising the seeds of around 2-4. Capsules are opened and then arils are eaten, usually seeds are often spat; the fruit tastes little sweet and sour.

Flowering and fruiting: February – July

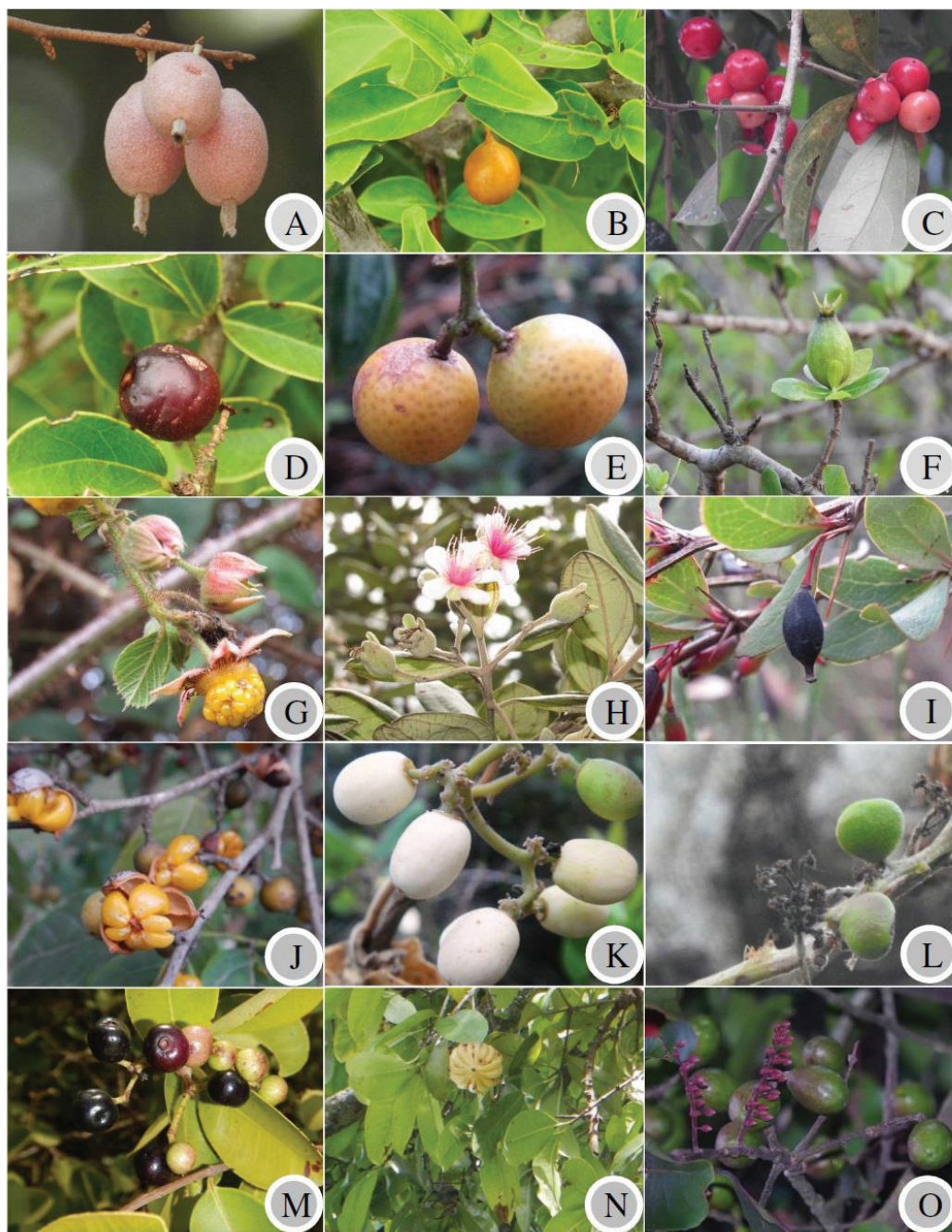


Figure 1. Selected wild, minor and edible fruits of Western Ghats in Southern India: (A) *Elaeagnus conferta*; (B) *Canthium coromandelicum*; (C) *Flacourtia Montana*; (D) *Flacourtia indica*; (E) *Toddalia asiatica*; (F) *Gardenia gummifera*; (G) *Rubus ellipticus*; (H) *Rhodomyrtus tomentosa*; (I) *Berberis tinctoria*; (J) *Aporosa cardiosperma*; (K) *Ziziphus rugosa*; (L) *Buchanania cochinchinensis*; (M) *Syzygium caryophyllatum*; (N) *Garcinia gummi-gutta*; (O) *Elaeocarpus tectorius*

Nutritional value: Moisture content (%): 92.43, protein (%): 0.02, fat (%): 1.16, reducing sugars (%): 4.91, non-reducing sugars (%): 1.06, total sugars (%): 5.98, vitamin C: traces, iron (mg/100g): 3.71, sodium (mg/100g): 11.6, potassium (mg/100g): 346.09 (Nazarudeen, 2010).

Artocarpus gomezianus Wall. ex Trecul. is an underutilized fruit tree found in the central Western Ghats.

Fruit description: Fruit is sorosis, subglobose, green turns yellow when ripe, weight (g): 52.59-245.50, length (cm): 40.80-70.90 and width (cm): 20.90-60.00, many seeded.

Flowering and fruiting: January – June.

Nutritive value: Ash (%): 5.33, moisture (%): 87.78, fat (%): 15.00, fibre (%): 8.43, protein (%): 0.36, carbohydrates (%): 8.62, zinc (ppm): 24.92, copper (ppm): 12.84, manganese (ppm): 103.49, iron (ppm): 802.01, sodium (%): 0.68, potassium (%): 1.47, phosphorus (%): 0.26, calcium (%): 0.26, magnesium (%): 0.18, nitrogen (%): 23.48, copper (ppm): 12.84. Whereas, the phenol and flavonoid content of fruits varied from 0.98-1.13 % and 0.41-0.73 % respectively. The fruits are consumed raw and also processed in to several value added products. Moreover, it is also used as spice in cooking south Indian dishes (Krishnamurthy and Sarala, 2013; Sarala and Krishnamurthy, 2014).

Berberis tinctoria Lesch. is a shrub endemic to Nilgiris – a part of UNESCO World Network of Biosphere Reserves.

Fruit description: Fruits are many seeded berries, obovoid-oblong, glabrous, shining, bluish black when ripe, with a size, length (cm): 1.2-1.5, diameter (cm): 0.5-0.7 and weight (g): 0.1-0.2.

Flowering and fruiting: March – July.

Nutritive value: The fruit has not been evaluated until now; however fruit extract has been evaluated for its total phenolics (410±0.02 mg/100g gallic acid equivalents (GAE), flavonoids (320±0.120 mg/100g quercetin equivalents) and antioxidant scavenging activity against various free radicals such as DPPH, O₂⁻, NO, OH[·] and ABTS including anti-hemolytic activity. Tribal communities use

various parts of this plant against liver related disorders and several chronic diseases including cancer. Furthermore, berberine, an alkaloid compound has been reported from this plant, wherein, this compound is used as drug by many pharmaceutical industries (Sasikumar et al., 2007; Singh et al., 2009; Sasikumar et al., 2012).

Buchanania cochinchinensis (Lour.) M.R. Almeida is a tree found in the deciduous forests of Western Ghats, native to tropical and subtropical India.

Fruit description: Fruit is drupe, black, stone hard, two valved, one seeded. Length (cm): 1.1-1.2, breadth (cm): 1.1-1.3. The ripe fruit is delicious and most often consumed raw; in several occasions, the seeds are roasted and served. Moreover, seeds are widely utilized as the kernel yields good amount of essential oil that finds several applications.

Flowering and fruiting: January – June.

Nutritive value: The seed comprises following proximate attributes: ash (%): 2.20, moisture (%): 3.60, crude fat (%): 38.00, total protein (%): 43.24, total carbohydrate (%): 12.96, total crude fibre (%): 18.50, phosphorus (mg/100 g): 593, zinc (mg/100 g) 3.32, aluminium (mg/100 g): 0.3, boron (mg/100 g): 0.6, calcium (mg/100 g): 70.00, copper (mg/100 g): 1.15, iron (mg/100 g): 4.80, magnesium (mg/100 g): 275.00, manganese (mg/100 g): 1.60. The kernel is known to be potential source of protein; oil from kernel is used as a substitute for almond oil and used extensively in cosmetic and nutraceutical applications (Munde et al., 2003; Singh et al., 2010; Kumar et al., 2012; Khatoon et al., 2015).

Carissa spinarum L. is an indigenous shrub, commonly found as hedge and a drought tolerant plant.

Fruit description: Fruit, an ovoid berry, 8-9 mm in length, 5-6 mm in diameter. Seeds 4-6, lanceolate, black in color with the weight (g), length (cm) and breadth (cm) of 2.56, 1.55 and 1.67 respectively. Fruit tastes sweet to astringent in flavor, and the fruit is known for its iron and ascorbic acid content. Several value added products are prepared.

Flowering and fruiting: February – June.

Table 1. List of selected potential wild, minor and edible fruits of Western Ghats in Southern India

Family	Botanical Name	Vernacular Name*	Habit	Mode of consumption and utilization	References
<i>Anacardium occidentale</i> L.	Anacardiaceae	Kan: Geru hannu, Godambe Tam: Munthiri, Andima Mal: Kasu mavu	Tree	Jam, jelly, vinegar, pectin, nonalcoholic and alcoholic beverages	Chakraborty et al., 1977; Mohanty et al., 2006
<i>Buchanania cochinchinensis</i> (Lour.) M.R. Almeida	Anacardiaceae	Kan: Nurukalu hannu Tam: Charam Mar: Charoli, Nuramaram	Tree	Consumed fresh, seeds- raw or cooked, oil is extracted from the seeds	Kumar et al., 2012
<i>Semecarpus anacardium</i> Blanco	Anacardiaceae	Kan: Gerr hannu Marathi: Bhilava, Bibba Mal: Sambiri	Tree	Dried fruits are consumed	Jadhav et al., 2015
<i>Spondias dulcis</i> Parkinson	Anacardiaceae	Kan: Sihi amate Hin: Ambarella	Tree	Consumed fresh, pickles	Bhat and Rajanna, 2016
<i>Annona muricata</i> L.	Annonaceae	Kan: Mullu ram phala Tam: Mullu sitha pazham	Tree	Ripe fruit consumed, fermented beverage	Minh, 2015
<i>Carissa spinarum</i> L.	Apocynaceae	Kan: Kouli hannu Mar: Karvand Hin: Jungli Karonda Tam: Kilakkay, Sirukilaa Mal: Kirkarmanji	Shrub	Consumed fresh, pickles, and jams are prepared	Fatima et al., 2013; Chauvan et al., 2015
<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	Kan: Kadu karjura hannu Tam: Kattinchu Mal: Niilanthent	Tree	Consumed fresh Dried fruits consumed	Jadhav et al., 2015
<i>Berberis tinctoria</i> Lesch.	Berberidaceae	Eng: Nilgiri barberry Tamil: Oosi kala	Shrub	Consumed fresh	Nayagam et al., 1993
<i>Cordia dichotoma</i> G. Forst.	Boraginaceae	Kan: Challe hannu Tam: Viricu Mal: Naruveeli Mar: Bhokar	Tree	Consumed fresh, pickled	Valvi and Rathod, 2011
<i>Opuntia dillenii</i> (Ker Gawl.) Haw.	Cactaceae	Kan: Papaskalli Tam: Sapatkalli	Shrub	Consumed fresh	Nayagam et al., 1993
<i>Garcinia gummi-gutta</i> (Linn.) Robson	Clusiaceae	Kan: Mantulli Tam: Kottukkappuli Mal: Kodampuli, Pinampuli	Tree	Fruit and juice are used as souring agent and butter from rind is prepared	Naveen and Krishnakumar, 2012; Namera et al., 2014
<i>Gardenia gummifera</i> L.f.	Rubiaceae	Kan: Bikke, Adavibikke Mal: Kambimaram Tam: Kambil	Small tree	Consumed fresh	Sivakamasundari et al., 2015
<i>Garcinia indica</i> (Thouars) Choisy	Clusiaceae	Kan: Murugalu, Kake mara Tam: Murgal Mal: Kotte pan, Kokumbrindeo Mar: Kokum	Tree	Consumed fresh, Juice and wine	Bafna, 2012; Naveen and Krishnakumar, 2013; Swami et al., 2014
<i>Garcinia xanthochymous</i> Hook	Clusiaceae	Kan: Devajarige Tam: Paccilai Mal: Beenakepuli	Tree	Consumed fresh, Wine	Rai et al., 2010; Mahesh et al., 2016
<i>Dillenia pentagyna</i> Roxb.	Dilleniaceae	Kan: Kaltega Mar: Karmal	Tree	Consumed fresh	Sundarapandian and Swamy, 1999
<i>Elaeagnus conferta</i> Roxb.	Elaeagnaceae	Kan: Halige hannu, Kerahuli Tam: Kulari Mal: Tholiar pan, Kattumunthiringa Mar: Ambgul Eng: Wild olive	Shrub	Consumed fresh	Valvi and Rathod, 2011; Patil et al., 2012

Family	Botanical Name	Vernacular Name*	Habit	Mode of consumption and utilization	References
	<i>Elaeocarpus tectorius</i> (Lour.) Poir.	Tam: Bikki palzam	Tree	Consumed fresh	Nayagam et al., 1993
	<i>Artocarpus hirsutus</i> Lam.	Kan: Hebbalasu, Kadu halsu Tam: Anjili Mal: Ayani	Tree	Consumed fresh and pickled	Vinay et al., 2014
	<i>Artocarpus gomezianus</i> Wall. ex Trecul.	Kan: Vatte huli Tam: Ottipila Mal: Arampulli, Pulichakka Eng: Monkey jack	Tree	Consumed fresh and juice, used as spice	Krishnamurthy and Sarala, 2013; Sarala and Krishnamurthy, 2014
	<i>Rhodomyrtus tomentosa</i> (Alton) Hassk.	Tam: Thavutu pazham Mal: Kirattan, Thavattukoyya	Shrub	Consumed fresh	Nayagam et al., 1993
	<i>Syzygium caryophyllatum</i> (L.) Alston	Kan: Kuntu nerle Mal: Shenjarel	Tree	Consumed fresh and wine	Shilpa and Krishnakumar, 2015
	<i>Syzygium jambos</i> (L.)	Kan: Pannerale, Jammu nerale Tam: Champai Mal: Malakkacampa Eng: Roseapple	Tree	Consumed as fresh juice and wine	Dhanabalan et al., 2014
	<i>Syzygium zylanicum</i> Alston	Kan: Bilinerale Mal: Pula	Tree	Consumed fresh and wine	Shilpa and Krishnakumar, 2015
	<i>Averrhoa bilimbi</i> L.	Kan: Bimbuli Tam: Pulima Mal: Vilumpi	Tree	Cooked and pickled	Bhat and Rajanna, 2016
	<i>Averrhoa carambola</i> L.	Kan: Karabalu Tam: Tamarattai Mal: Caturappuli	Tree	Consumed fresh, juice and wine	Napahde et al., 2010; Bhat et al., 2011; Dasgupta et al., 2013; Paul and Sahu, 2014; Bhat and Rajanna, 2016
	<i>Passiflora edulis</i> Sims.	Eng: Passion fruit Kan: Sharbath balli Tam: Odey annu	Shrub	Consumed fresh, juice is prepared	Pruthi and Girdhari, 1955
	<i>Aporosa cardiosperma</i> (Gaertn) Merr.	Kan: Salle mara Tam: Vittil Mal: Vetti	Tree	Ripe fruits consumed	Bhat and Rajanna, 2016
	<i>Phyllanthus emblica</i> L.	Eng: Indian gooseberries Kan: Kadu nelli, Bettad nellikayi Tam: Nelli Mal: Nellikka	Tree	Consumed fresh, jam, juice and wine are prepared	Nambiar et al., 2016; Peerajan et al., 2016
	<i>Ziziphus oenopolia</i> (L.) Mill.	Kan: Pargi hannu Tam: Pulichi	Shrub	Consumed fresh	Jadhav et al., 2015
	<i>Ziziphus jujube</i> Mill.	Kan: Bore hannu, Bari hannu Mar: Bor	Tree	Consumed fresh	Jadhav et al., 2015
	<i>Ziziphus rugosa</i> Lamk.	Kan: Mullu hannu Mar: Burgi, Yeruni Mal: Kotte pan	Shrub	Consumed fresh, juice and dosa are prepared	Krishnamurthy and Sarala, 2011
	<i>Rubus ellipticus</i> Smith	Kan: Kadumulli hannu Tam: Mullu pazham, Thuppa mulli	Shrub	Consumed fresh	Nayagam et al., 1993
	<i>Rubus racemosus</i> Roxb.	Tam: Mullu pazham, Yemmemulli	Shrub	Consumed fresh	Nayagam et al., 1993
	<i>Rubus rugosus</i> Smith.	Tam: Mullu pazham	Shrub	Consumed fresh	Nayagam et al., 1993
	<i>Canthium coromandelicum</i> (Burm. f.) Alston	Kan: Kare hannu Tam: Kaaraichedi Mal: Kare pan	Shrub	Consumed fresh	Sambandan and Dhatchanamoorthy, 2012
	<i>Ixora coccinea</i> L.	Kan: Hole daswala, Kusumaale hannu Mal: Thetti, Chethi,	Shrub	Consumed fresh	Jadhav et al., 2015

Family	Botanical Name	Vernacular Name*	Habit	Mode of consumption and utilization	References
<i>Aegle marmelos</i> (L.) Correa	Rutaceae	Thechi Kan: Bilvapatre Tam: Vilvam Mal: Mavilavu	Tree	Juice and wine	Pandaa et al., 2014
<i>Glycosmis pentaphylla</i> (Retz.) DC.	Rutaceae	Kan: Bakkina kannu Tam: Kula pannai Mal: Panchi Mar: Maenaki, Kirmira	Shrub	Consumed fresh	Valvi and Rathod, 2011
<i>Toddalia asiatica</i> (L.) Lam.	Rutaceae	Kan: Kadu manasu Tam: Kattu milaku, Siru-kindu Mullu annu	Woody liana	Consumed fresh	Nayagam et al., 1993
<i>Flacourtia montana</i> J. Graham.	Salicaceae	Kan : Sampige hannu Mar: Champari, Ataki Mal: Male kakkade	Tree	Consumed fresh	Abhishek and Thangadurai, 2015
<i>Flacourtia indica</i> (Burm. f.) Merr.	Salicaceae	Kan: Karimullu hannu Tam: Cottaikkalaa Mal: Kurumuli Mar: Karai, Galguggar, Bhenkal	Shrub	Consumed fresh	Valvi and Rathod, 2011; Jadhav et al., 2015
<i>Schleichera oleosa</i> (Lour.)	Sapindaceae	Kan: Cakota Tam: Kumbadiri, Poovahti Mar: Kosab, Koshimb, Kusum	Tree	Consumed fresh, shoots as vegetable	Valvi and Rathod, 2011
<i>Mimusops elengi</i> L.	Sapotaceae	Kan: Renjalu hannu Mal: Elengi Hin: Bakul	Tree	Consumed fresh	Valvi et al., 2011
<i>Lantana camara</i> L.	Verbenaceae	Kan: Chadurangi, Simesime Tam: Uni Mar: Ghaneri, Tantani	Shrub	Consumed fresh	Venkatachalam et al., 2011a

*Eng: English, Hin: Hindi, Kan: Kannada, Mal: Malayalam, Mar: Marathi, Tel: Telegu, Tam: Tamil

Nutritive value: Moisture: 81.05 %, proteins: 2.07 %, fat: 1.30 %, carbohydrates: 18.66 %, calcium: 29 mg/100g, phosphorus: 32.1 mg/100g, iron: 3.45 mg/100g, total phenolics: 5.31 mg TAE/g, total flavonoids: 0.44 mg QE/100 g (Chauvan et al., 2015).

Elaeagnus conferta Roxb. is a thorny climber shrub, native to tropical and subtropical regions, found across evergreen to semi-evergreen forests.

Fruit description: The fruit is elliptical in shape, color is light pink with white coloured micro spots, single seeded, weight (g): 4.21, length (cm): 3.19, breadth (cm): 1.54. The fruit is usually consumed fresh, highly perishable.

Flowering and fruiting: November – March.

Nutritive value: Moisture content (%) 77.00, titrable acidity (g/100g): 2.37, total sugars (mg/100mg): 39.00, reducing sugars (mg/100mg): 35.00, non-reducing sugars (mg/100mg): 4.00, ash (%): 22.02, copper (mg/kg): 0.049, manganese (mg/kg): 0.145, iron (mg/kg): 0.628, zinc (mg/kg): 0.411, calcium (mg/kg): 17.06, magnesium (mg/kg): 1358.00, phenolics (mg/100mg): 6.08,

flavonoids (mg/100mg): 11.68, ascorbic acid (mg/100g): 8.20. The fruits are used as medicine for the treatment of indigestion (Patil et al., 2012; Valvi et al., 2014b; Khilari and Sharma, 2016).

Elaeocarpus tectorius (Lour.) Poir. is a tall tree up to 40 meters, found in the higher altitude of the Nilgiris.

Fruit description: Green fruits are sweet to taste, single seeded, weight (g): 5-8, diameter (cm): 1.8-2.1 and length (cm): 2.8-3.2.

Flowering and fruiting: March – August.

Nutritive value: Moisture (%): 59.30, proteins (mg/100g): 1.4, fibre (mg/100g): 1.6, calcium (mg/100g): 37.00, phosphorous (mg/100g): 26.00, iron (mg/100g): 3.10, carotenes (mg/100g): 190.00, thiamine (mg/100g): 0.02, riboflavin (mg/100g): 0.06, niacin (mg/100g): 0.30. Traditionally, tribal communities utilize the fruits to treat various microbial infections and diseases including rheumatism and piles (Nayagam et al., 1993; Raganathan and Senthamarai, 2014; Sharvani and Devaki, 2014).

Flacourtia indica (Burm. f.) Merr. is a small shrub found in the deciduous forest of Western Ghats region.

Fruit description: Fruit is globular in shape, reddish to reddish black when ripe, fleshy, up to 4-10 seeded, tastes sweet to acidic, generally consumed raw, length (cm): 1.0-1.2, breadth (cm): 1.2-1.6.

Flowering and fruiting: January – October

Nutritive value: Moisture (%): 74.4, ash (%): 2.57, total sugar (%): 14.74, phenol (mg/g): 1.63, ascorbic acid (mg/100g): 53.44, crude fibre (%): 6.01, fat (%): 0.17, potassium (mg/100g): 1184.3, calcium (mg/100g): 434.8, sodium (mg/100g): 146.3, iron (mg/100g): 15.23, manganese (mg/100g): 10.37, copper (mg/100g): 7.6. It is used in making jams, jellies and unripe fruits are astringent in flavor and usually pickled (Rathod and Valvi, 2011).

Flacourtia montana J. Graham. being named on the type of vegetation it grows in montane forests is endemic to Western Ghats and grows to a height of 8-10 m. It is a small-medium sized tree often armed with heavy thorns and branches with spines.

Fruit description: Fruits are globous, red when ripe and taste sweet with astringent flavor, 4-6 seeds present, weight (g): 0.5-0.8, length (cm): 1.2-1.5, breadth (cm): 0.7-1.1.

Flowering and fruiting: September – March.

Nutritive value: Moisture (%): 77.10, titrable acidity (%): 0.25, total sugars (mg/100mg): 64, reducing sugars (mg/100mg): 9.88, non-reducing sugars (mg/100mg): 54.11, ash (%): 8.43, calcium (%): 0.30, magnesium (%): 0.60, potassium (%): 0.89, sodium (mg/100g): 57.10, phenolics (mg/100mg): 1.63, flavonoids (mg/100mg): 0.66, ascorbic acid (mg/100g): 23.30. The methanolic fruit extract exhibits antioxidant activity against various free radicals (Abhishek and Thangadurai, 2015).

Garcinia gummi-gutta (L.) Roxb. is widely distributed along the lower altitude of Western Ghats (coastal region). The plant is native to Indonesia and tree grows up to 10-16 meters in length.

Fruit description: The unripe fruit is green in color, ripe fruit will be yellow to pale yellow, 6 to 8 seeds present, looks similar to tiny pumpkin in shape, weight (g): 70-80, diameter (cm): 5-6, length (cm): 7-9.

Flowering and fruiting: January – June.

Nutritive value: Moisture (%): 86.91, total sugars (mg/100mg): 8.6, reducing sugars (mg/100mg): 5.92, non-reducing sugars (mg/100mg): 2.67, proteins (%): 0.61, fibre (%): 3.1, sodium (%): 2.1, potassium (%): 169.7. Fruit juice exhibits anti-scorbutic, anthelmintic and cardiotoxic properties. Moreover, fruit rind and seeds are potential source of bioactive compounds such as lipids, fatty acids and nutraceuticals. The fruit is commercially exploited for its weight loss properties (Nazarudeen, 2010; Naveen and Krishnakumar, 2012; Naveen and Krishnakumar, 2013; Parthasarathy and Nandakishore, 2014; Mahesh et al., 2016).

Garcinia indica (Thouars) Choisy., a tree commonly found along the coastal area of the Western Ghats. The tree grows up to 10-18 meters with drooping branches.

Fruit description: The ripe fruit is red or dark purple colored containing 3-8 large seeds. The fruit is spherical, diameter (cm): 2.5 to 3.0, weight (g): 15-30.

Flowering and fruiting: November – May.

Nutritive value: Fresh rind of Kokum has moisture (%): 80, protein (%): 2, tannin (%): 2.8, pectin (%): 5, fibre (%): 14, total sugars (%): 4.1, fat (%): 1.4, ascorbic acid (%): 0.06. *Garcinia* comprises several potential bioactive constituents, majority proportions of them being garcinol and hydroxycitric acid (HCA). The pulp of the fruit is acidic that tastes sour. Generally, the rind of the fruit is commercially exploited as it is considered to be potentially therapeutic; it is used as souring agent in most of south Indian coastal cuisines. Moreover, the butter extracted from rind finds application in nutraceutical and cosmetic industries. Furthermore, is used to prepare several kinds of beverages and functional foods (Krishnamurthy et al., 1982; Krishnamurthy, 1996; Krishnamurthy and Sampathu, 1988; Bhat et al., 2005; Baliga et al., 2011; Swami et al., 2014; Jagtap et al., 2015).

Garcinia xanthochymus Hook. F. T. Anderson. is a tree native to India and Myanmar, distributed in the mid altitudes of Western Ghats region; tree grows up 80-100 meters.

Fruit description: Fruit is yellow in color, subglobose in shape, tastes sour, 1-4 seeded, weight (g): 57-65, diameter (cm): 5-9, length (cm): 5.0-6.5.

Flowering and fruiting: March – August.

Nutritive value: Moisture (%): 80.96, fat (%): 7.57, ash (%): 1.65, fibre (%): 2.73, protein (%): 5.01, phenolics (mg/g): 31.31, flavonoids (mg/g): 5.313, ascorbic acid (%): 0.14, calcium (mg/kg): 134.87.

Fruits are utilized to prepare fermented beverages comprising rich nutritional compositions. The fruit is rich in hydroxycitric acid, a compound known for its potential anti-obesity and fruits are used to prepare several food products including jams, vinegar and preservatives. Beverage made out of dried fruit is used against constipation and excessive flatulence. Furthermore, fruit possess potential bioactive compounds that are antioxidant, anti-inflammatory and anticancer in nature (Konoshima et al., 1970; Baslas and Kumar, 1979; Singh et al., 1991; Facciola, 1998; Chanmahasathien et al., 2003; Baggett et al., 2005; Chen et al., 2010; Rai et al., 2010; Lim, 2012; Parthasarathy and Nandakishore, 2014; Sharma et al., 2015).

Ixora coccinea L. is a small evergreen shrub found in lower altitude of Western Ghats, the plant is native to India and Sri Lanka.

Fruit description: A red to crimson coloured globose berry, tastes sweet, two seeded.

Flowering and fruiting: March – July.

Nutritive value: Moisture content (%): 82.9, total sugars (mg/100mg): 16.2, reducing sugars (mg/100mg): 10.15, non-reducing sugars (mg/100mg): 6.05, proteins (%): 0.28, fibre (%): 0.9; sodium (%): 9.88, potassium (%): 197.69. Traditionally tribal communities use various parts such as leaf, flower and roots to treat several diseases, and especially the flower decoction is used to treat against several diseases including dysentery, hypertension and menstrual irregularities (John, 1984; Batugal, 2004; Kirtikar and Basu, 2005; Saha et al., 2008; Nazarudeen, 2010; Bose et al., 2011; Baliga and Kurian, 2012).

Lantana camara L. is an exotic shrub widely distributed in the Western Ghats.

Fruit description: The fruit is a drupaceous, green-black in colour, diameter (cm): 0.5-0.6.

Flowering and fruiting: Throughout the year

Nutritive value: Moisture (%): 8.49, ash (%): 2.75, proteins (%): 17.11, fat (%): 4.29, fibre (%): 12.76, carbohydrates (%): 45.7, calcium (ppm): 1061.84, magnesium (ppm): 869.22,

potassium (ppm): 889.92, sodium (ppm): 679.42, copper (ppm): 1.98, iron (ppm): 95.14, phosphorous (ppm): 875.16, zinc (ppm): 784.93. Methanolic extract of fruits exhibits anti-diabetic activity by significantly reducing blood glucose levels in streptozotocin-induced diabetic rats (Ojo et al., 2010; Venkatachalam et al., 2011a; Venkatachalam et al., 2011b; Ajiboye et al., 2014).

Opuntia dillenii (Ker Gawl.) Haw. is native to Central America and widely distributed in the Western Ghats.

Fruit description: A berry, ovoid, glochidiate, purple when ripe, many seeds present. The fruits are occasionally eaten, length (cm): 5-6, breadth (cm): 2.5-3.5.

Flowering and fruiting: February – July.

Nutritive value: Potassium (mg/100g): 876.3, calcium (mg/100g): 17.6, magnesium (mg/100g): 9.51, sodium (mg/100g): 124.3, phosphorous (mg/100g): 29.2, iron (mg/100g): 5.16, zinc (mg/100g): 0.884, manganese (mg/100g): 1.285, aluminum (mg/100g): 1.16, barium (mg/100g): 1.27; fruits are often consumed raw. Pulp is utilized to make into syrup, jam or jelly, a rich source of betalins (Kalegowda et al., 2015; Pooja and Vidyasagar, 2016).

Rhodomyrtus tomentosa (Altson) Hassk. is native to China, it is distributed on the higher altitudes of the Western Ghat region.

Fruit description: Fruit is an ellipsoid berry, diameter (cm): 1–1.5 with a persistent calyx, purplish black in colour, soft and sweet and several seeded.

Flowering and fruiting: March – July.

Nutritive value: Moisture (%): 83, titrable acidity (g CAE/100g): 0.43, protein (g/100g): 4.0, lipids (g/100g): 4.19, sugars (g/100g): 19.96, total dietary fibre (g/100g): 66.56, ascorbic acid (mg/100g): 15.29, calcium (mg/100g): 200.24, phosphorous (mg/100g): 57.85, iron (mg/100g): 4.20, potassium (mg/100g): 602.93, sodium (mg/100g): 113.64, magnesium (mg/100g): 66.51, copper (mg/100g): 1.10, manganese (mg/100g): 8.79, zinc (mg/100g): 1.65, total phenolics (mg GAE/g DW): 49.21. Fruit extracts significantly exhibits antioxidant activity (Nayagam et al, 1993; Lai et al., 2015).

Rubus ellipticus Smith. is a thorny shrub found across higher altitude of Western Ghats region; the plant grows up to 3-4 meters in height.

Fruit description: Yellow spherical berries looks similar to raspberry, diameter (cm): 0.9-1.0 and weight (g): 0.2-0.4; fruit is consumed fresh, tastes very sweet.

Flowering and fruiting: February – June.

Nutrition value: Moisture (%): 80.60, total soluble solids (%): 6.60, total sugars (%): 8.50, carbohydrate (%): 72.70, fat (%): 7.10, fibre (%): 7.90, protein (%): 4, ascorbic acid (%): 0.011, total phenols (mg GAE/100g): 6100±0.082, total flavonoids (mg QE/100g): 320±0.120 (Jeeva, 2009; Karuppusamy et al., 2011).

Schleichera oleosa (Lour.) Oken. is a tree found in deciduous forest of Western Ghats region.

Fruit description: The ripe fruit is eaten raw, a drupe ellipsoid to sub-globular in shape, taste acidic, length (cm): 1.5-2.5, breadth (cm): 1-2.

Flowering and fruiting: March – July.

Nutritive value: Moisture (%): 77.4, carotenoid (%): 3.1, reducing sugar (%): 11.7, starch (%): 9.2, total sugar (%): 7.23, phosphorus (%): 0.453, potassium (%): 1.167, ascorbic acid (mg/g): 1.05, phenol (mg/g): 4.50, crude fibre (%): 4.53. Usually, unripe fruits are pickled (Valvi and Rathod, 2011; Valvi et al., 2014a).

Syzygium caryophyllatum (L.) Alston. is an evergreen small tree up 2-3 meters distributed in lower altitude of Western Ghats, endemic to Sri Lanka. It is an endangered plant, categorized in Red List by International Union for Conservation of Nature and Natural Resources (IUCN).

Fruit description: It is a purple small sized berry, oval in shape, weight (mg): 300-500, length (cm): 0.4-0.6, breadth (cm): 0.5-0.8.

Flowering and fruiting: January – July.

Nutritive value: Moisture content (%) 63.17, titrable acidity (g/100g): 0.770 g of acids, total sugars (mg/100mg): 37.70, reducing sugars (mg/100mg): 30.40, non-reducing sugars (mg/100mg): 7.30, vitamin C (mg/100g): 50, proteins (mg/100mg): 3.37, total anthocyanin content: 240.36 mg/l. Methanolic extract and aqueous extract of fruit had 75.16 and 33.55 mg/g phenolics, respectively. The flavonoid content of methanol and aqueous extract of fruit had 27.2 and 8.25 mg/g respectively. Fruit

has antibacterial potential and leaf extract exhibits antimicrobial, antioxidant and anticancer activity (Gayathri et al., 2012; Shilpa and Krishnakumar, 2015).

Ziziphus rugosa Lamk. is a large straggling armed shrub, grown widely in the dry deciduous forest of central Western Ghats.

Fruit description: Drupe to 1.3 cm, globose, white or pale yellow, glabrous, maximum weight (g) 1-2, length (cm): 0.9-1.5, width (cm): 1.1-1.5.

Flowering and fruiting: November – May.

Nutritive value: Ash (%): 50, moisture (%): 62.2, fat (%): 5, fibre (%): 40, protein (%): 11, carbohydrates (%): 26, zinc (ppm): 3.074, copper (ppm): 62.4, manganese (ppm): 609.1, iron (ppm): 916.728, sodium (%): 18.5, potassium (%): 168, phosphorus (%): 16.5, calcium (%): 17.1, magnesium (%): 22, nitrogen (%): 19.4. Fruits are used in treatment of throat irritations (Pandey et al., 1985; Acharya et al., 1988; Pandey et al., 1988; Krishnamurthy and Sarala, 2011; Kaennakam et al., 2013).

CONCLUSIONS

Fruits listed above have to be considered as horticultural crops at a foremost priority, likewise suitable mass propagation techniques have to be adapted in order to conserve these prominent fruits for the present and future generations that are under the threat of extinction. In the recent past, researchers have made considerable attempts in listing the nutritional composition and in developing techniques of mass propagation for some of these wild fruits. The government and semi-government organizations have to come forward and undertake necessary steps/policies in conserving these medicinal, wild, and minor fruit plant species. Moreover, in recent past several underutilized fruits are gaining prominence and have been successfully utilized for preparation of value added products and functional foods, thus creating its own niche in the food industry and nutraceuticals. This substantial increase in sustainable utilization of bioresources has made a tremendous impact on the livelihoods of tribal and rural communities, creating wide array of job opportunities and as

a source of income and awareness among major populations.

Nevertheless, over the past few decades several scientific studies have been undertaken to understand phytochemicals present in various plant parts such as the leaves, barks and root. However, comparatively only few or rather rare studies have been conducted on fruits. Hence, it is quite significant to carry more intensive scientific studies on these wild edible fruits. It is believed that regular consumption of these fruits will aid in preventing several diseases and disorders including obesity, diabetes and chronic diseases. Since fruits are thought to be rich in nutrients, polyphenols (flavonoids and stilbenes) and carotenes, in recent past, several reports have successfully demonstrated that these bioactive compounds are directly attributed to antioxidant properties against various free radicals. Anti-nutritional factors have to be evaluated before their utilization and consumption. However, recent statistics shows that consumption and utilization of fruits and fruit products is declining. Hence, more scientific studies is required in elucidating the structure and properties of important bioactive compounds present in these minor wild edible fruits, so that more awareness is created among the consumers, which will subsequently benefit to fight several nutrition related problems.

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