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Traditional Nutritional Attributes of Native Flora of the Southwest Coast of India

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Abstract Coastal regions of Karnataka and Kerala are well known for richness of native or indigenous plant species of ethnic value to meet the nutritional requirements. Approaches of nutritional use of native plant resources differ between geographic as well as ethnic groups. Based on folk knowledge, the present study deals with 19 plant species (in 17 genera and 16 families) used mainly for nutritional purpose. Various parts of plants used, seasonal availability and preparation of traditional dishes with brief account of medicinal value are discussed. Modern lifestyle seems to overlook indigenous knowledge and strength of native plant species in human nutrition. In depth scientific investigations will decipher nutritional versatility, unique formulations, value additions and industrial potential of indigenous plant species.

Keywords: Ethnic knowledge, ethnic nutrition, ethanobotany, ethnomedicine, indigenous plants, native plants, wild plants

Introduction

As several ethnic communities are in constant contact with wild plant species occurring in their vicinity, a complex relationship has been established to utilize such plant species to fulfil specific nutritional or medicinal requirements (Soejarto *et al*., 2005). Most of such ethnic knowledge on nutritional or health promotion prevails as folklore, which has been evolved from several generations (Berkes 2008). It is inevitable to relay on traditional knowledge or ethnic knowledge to conserve indigenous plant sources as targeted by the Convention on Biological Diversity (CBD, 2011). Such traditional knowledge although strongly believed to be more authentic, scientific validation is necessary to understand exact nutritional advantages precisely for popularization and conservation. In the recent past, inventory, exploration and documentation of indigenous or region-specific wild plant resources gained more attention of researches owing to their potential and

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inexpensive nutritional benefits. Investigation on native plant species as source of nutrition is fascinating due to food security, to compensate food scarcity, and alternative to expensive routinely used vegetables and fruits (Sridhar and Karun, 2016). Based on ethnic knowledge, many indigenous plant species and their products serve as potential source of disaster food during adverse situations or during offseason (Bhagya *et al*., 2013). In coastal regions of Karnataka and Kerala States, several ethnic nutritional and ethnomedicinal practices are followed as these regions are rich in riverine, mangrove and marine biodiversity (Sridhar and Bhagya, 2007; Bhagya and Sridhar, 2009; Bhagya *et al*., 2013; Pullaiah *et al*., 2016). The current communication briefly highlights common and easily accessible plant species in the southwest coast of India and their specific parts used for ethnic food preparations. This study embodies experiences of utilization of native or indigenous plant species as nutritional source mainly by the Havyaka community. However, even though same plant species serve as potential source of diet for other ethnic groups (e.g. Konkani), the method of food preparation as well as organoleptic qualities varies.

Study area and plant species

The ethnic information pertain to plant species employed for indigenous nutrition was gathered by interviewing older people especially women folk belong to Havyaka community in two places: Mundamoole, Manila Village, Bantwal (Karnataka) (12°41'N, 75°4'E) and Payam, Iriyanni, Kasaragod (Kerala) (12°29'N, 75°7'E).

Nineteen plant species (3 herbs, 2 shrubs, 3 climbers and 11 tree species) used mainly for nutritional purpose were documented. Among them, 13 species are common (*Artocarpus altilis, A. heterophyllus*, *Averrhoa bilimbi, Basella alba, Cucurbita moschata, Garcinia indica, Hibiscus rosa-sinensis, Moringa oleifera, Oxalis corniculata, Sauropus androgynus, Syzygium caryophyllum, Talinum triangulare* and *Vigna unguiculata*), four species are frequent (*Citrus aurantium, Holarrhena pubescens Madhuca neriifolia* and *Solanum torvum*) and two species are rare (*Averrhoa carambola* and *Oroxylum indicum*). Table 1 enlists botanical nomenclature, family, habit, common names (English, Kannada and Tulu), principal part used for nutrition, ethnic dishes, edibility and medicinal uses.

Depending on the plant species, specific parts like leaves, stem, flowers, pods, fruits and seeds are used as nutritional source. Literature knowledge on nutritional benefits of these plant species were not documented deliberately to project only traditional knowledge of specific ethnic community and geographic region. However, among the plant species dealt, many of them have

nutraceutical as well as medicinal properties based on local experience and literature source. Table 2 gives details of various ethnic dishes prepared using different parts of plant species.

Table 1. Details of indigenous plant species and their specific parts used for traditional food preparation in southwest India (*, E-English, K-Kannada, T-Tulu; **, See Table 2 for details; ***, Based on current study and literature).

Botanical name and family	Common names*	Part used for nutrition	Ethnic dish**	Edibility and medicinal value***
Leaves				
***Madhuca neriifolia* (Moon) H. J. Lam. (Sapotaceae) (Fig. 1i) (Tree)**	Butter tree (E); Ulinannil and Naanilla hannu (K); Naanilu and Naanila (T)	Tender leaves	Halakodi/Holakodi tambuli	Fruits edible; seeds provide edible oil and it has medicinal value
***Oxalis corniculata* L. (Oxalidaceae) (Fig. 1j) (Herb)**	Creeping wood sorrel (E); Hulisoppu (K); Pulichappu and Puliyaral (T)	Leaves and whole plants	Saaru	Whole plant and leaves are medicinal
***Sauropus androgynus* (L.) Merr. (Phyllanthaceae) (Herb)**	Star gooseberry (E); Chakramuni soppu/Vitamin soppu (K and T)	Tender leaves	Chatni, Kodilu, Saaru, Taalu/Palya, Tambuli and Patrode	Leaves are medicinal
***Syzygium caryophyllum* (L.) Alston (Myrtaceae) (Tree)**	Indian plum (E); Kuntaangila (K); Kuntaala (T)	Tender leaves	Halakodi/Holakodi tambuli	Fruits are edible; leaves are medicinal
Leaves and stem				
Basella alba* L. (Basellaceae) (Climber) **	Malabar spinach (E); Basale (K and T)	Leaves and Stem	Dose, Gasi and Kodilu	Leaves are medicinal
***Talinum triangulare* (Jacq.) Willd. (Portulacaceae) (Herb)**	Ceylon spinach (E); Nelabasale (K and T)	Leaves and stem	Kodilu, Melaara, Patrode, Pakoda/Poodi, Saaru and Taalu/Palya	Leaves are medicinal

Leaves and pods				
***Vigna unguiculata* (L.) Walp. (Fabaceae) (Climber)**	Cow pea (E); Alasande (K); Lattande (T)	Leaves and pods	Kodilu, Melaara, Saaru and Taalu/Palya	Leaves, pod peel and seeds are medicinal
Leaves, flowers and fruits				
***Cucurbita moschata* Duchesne (Cucurbitaceae) (Fig. 1e and f) (Climber)**	Pumpkin (E); Cheenikayi (K); Kembude (T)	Leaves, flowers and fruits	Bendi/Kalasu, Chatni, Kodilu, Kottige, Menaskayi , Payasa, Saaru and Taalu/Palya,	Fruits and fruit stalks are medicinal
***Moringa oleifera* Lam. (Moringaceae) (Tree)**	Drumstick (E); Nuggekayi (K); Nurge (T)	Leaves, flowers and fruits	Kodilu, Saaru and Taalu/Palya	Leaves, roots, pods and bark are medicinal
Flowers				
***Hibiscus rosa-sinensis* L. (Malvaceae) (Shrub)**	Hibiscus (E); Daasavala (K and T)	Flowers	Dose and Saaru	Leaves, buds and flowers are medicinal
Flowers and fruits				
***Holarrhena pubescens* Wall. ex G. Don. (Apocynaceae) (Tree)**	Bitter oleander (E); Kodasige (K); Kodanchi (T)	Flowers and Fruits	Kodilu, Menaskai, Saaru, Tambuli, Taalu/Palya and	Flower and bark are medicinal
Bark and pods				
***Oroxylum indicum* (L.) Kurz (Bignoniaceae) (Tree)**	Broken bones tree (E); Aanemungu (K); Aanemunku (T)	Tender pods	Pickle and Taalu/Palya	Bark and fruits are medicinal
Fruits				
***Artocarpus altilis* (Parkinson ex F.A. Zorn) Fosb. (Moraceae) (Tree)**	Breadfruit (Eng); Deevihalasu (K); Jeegujje (T)	Fruits	Chatni, Chips, Dose, Kodilu, Papad, Taalu/Palya and Pakoda/Poodi	-
***Averrhoa bilimbi* L. (Oxalidaceae) (Fig. 1a) (Tree)**	Bilimbi (E); Beembuli (K); Beempuli (T)	Fruits	Pickle and Saaru	Fruits are medicinal
***Averrhoa carambola* L. (Oxalidaceae) (Fig. 1b) (Tree)**	Starfruit (E); Daarehuli (K); Daarepuli (T)	Fruits	Juice, Pickle and Saaru	Fruits are medicinal

Citrus aurantium **L. (Rutaceae) (Fig. 1c and d) (Tree)**	Bitter orange (E); Kanchuhuli (K); Kaipure (T)	Fruits	Chatni, Chitranna, Pickle and Tambuli	Fruits, rind and fruit peel are medicinal
Garcinia indica **(Thouars) Choisy (Clusiaceae) (Fig. 1g and h) (Tree)**	Kokum (E); Punarpuli (K and T)	Fruits and fruit peel	Juice, Saaru, Squash and Syrup	Fruits and fruit peel are medicinal
Solanum torvum **Sw. (Solanaceae) (Fig. 1k) (Shrub)**	Turkey berry (E); Kadu badane (K); Kudane (T)	Tender fruits	Gojju, Kodilu and Saaru	Leaves and fruits are medicinal
Fruits and seeds				
Artocarpus heterophyllus **Lam. (Moraceae) (Tree)**	Jackfruit (E); Halasu (K); Pelakayi (T)	Raw and ripened perianth and seeds	Chips, Dose, Gasi, Genesale, Hoilge, Kodilu, Kottige, Manni, Ode, Papad, Payasa, Rotti, Suttavu, Taalu/Palya, Perati/Berati, Pickle, Santani and Undlakaalu	Leaves are medicinal

Leaves

Madhuca neriifolia (Fig. 1i)

A small riparian tree grows up to 10 m height with simple medium size glossy leaves. The flowers are yellowish-white, fruits are purplish-green when raw and turn into light-green on maturity. Each fruit usually contains single seed and occasionally two, which resembles seeds of sapota (*Manilkara zapota*). Flowering and fruiting occurs during February to May.

The tender leaves are used in the preparation of 'Halakodi'/Holakodi tambuli' (Table 2). Fruits have mild taste and edible. Seeds are sun-dried before extracting edible oil, which is used for frying and to coat the base during preparation of 'Dose' (fermented and non-fermented rice dish). It is also used as hair oil. Oil is also useful for topical applications especially swellings, skin diseases (wounds and sores) and rheumatism (Jayaweera 1982).

Oxalis corniculata (Fig. 1j)

It is a creeping weed commonly distributed in yards, gardens, nursery and plantations. Leaves are dissected into three heart-shaped leaflets, produce small bright-yellow flowers. The whole plant tastes sour; stem, leaves and flower stalks are hairy. Flowering and fruiting occurs throughout the year.

The leaves are used in the preparation of 'Saaru' (Table 2) and 'Kashaya' (decoction with spices). The whole plant 'Kashaya' cures diarrhoea; the crushed whole plant boiled with buttermilk used to cure indigestion and diarrhoea in infants as well as cattle. The leaves are also effective against skin diseases especially warts and corns. The extract of whole plants mixed with onion is useful to remove warts. The leaf extract mixed with castor oil is useful in treating insomnia (Badwaik *et al.* 2011).

Figure 1. Representative native plant species used for traditional nutrition in southwest India: Tender and mature fruits of *Averrhoa bilimbi* (a); tender and mature fruits of *Averrhoa carambola* (b); unripened fruits of *Citrus aurantium* L. (c & d); leaves and flowers of *Cucurbita moschata* (e & f); unripened and ripened fruits of *Garcinia indica* (g & h); tender leaves of *Madhuca neriifolia* (i); leaves of *Oxalis corniculata* (j); flowers and tender fruits of *Solanum torvum* (k).

Table 2. Details of traditional dishes prepared out of native plant species in southwest India.

Local name	Usage	Preparation	Mode of consumption
Chatni	Side dish	Material cooked and ground with grated coconut, salt, green/fried red chilli and tamarind juice; seasoned with mustard, red chilli and curry leaves.	Sides for Dose, rice, Chapathi and Rotti
Chitranna	Lemon rice	Cooked rice seasoned with oil, mustard, turmeric powder, red chilli and chopped green chilli; the fruit juice and salt was added according to taste.	Breakfast
Dose	Unfermented rice dish	Material ground with soaked rice by addition of salt, the dough is useful to prepare Dose. Spices can be added during griding depending on taste.	Breakfast
Gasi	Side dish	Material cooked with turmeric powder, salt, jaggery and tamarind; the paste of grated coconut, garlic and red chilli are added; seasoned with mustard, red chilli and curry leaves.	Sides for Chapati, Dose, Poori, Rotti and rice
Genesale	Sweet/Snack	Material chopped and cooked with jaggery and cardamom powder; rice paste layered thinly on banana leaf, on top above sweet mixture was placed, rolled and steam baked.	Evening snack or as sweet; consumed along with ghee; can be stored for 2–3 days
Gojju	Side dish	Material cooked with salt, turmeric powder, chilli powder, jaggery and tamarind juice; seasoned with mustard, red chilli and curry leaves.	Sides for rice
Halakodi/ Holakodi tambuli	Soup	Tender leaves of *Madhuca nerriifolia*, *Anacardium occidentale*, *Ixora coccinia*, *Psidium guajava*, *Getoonia floribunda*, *Holigarna arnottiana* and *Syzygium caryophyllatum* are fried in ghee and ground with salt, cumin seeds and grated coconut. The paste can be mixed with buttermilk and seasoned with mustard, red chilli and curry leaves.	Sides for rice or consumed as soup; one time use usually for lunch
Holige	Sweet	Seeds cooked and ground with jaggery, the paste rolled into small spheres and covered with maida dough; rolled like chapathi and cooked.	Consumed with ghee; can be preserved for a week

Kodilu	Sambar	Material cooked with salt, turmeric powder, jaggery and tamarind juice; mixed and boiled with paste of grated coconut, fried red chilli, coriander, spilt beans of black gram, cumin seeds and methi seeds; seasoned with mustard, red chilli and curry leaves.	Consumed along with rice
Kadubu/ Kottige	Steam-baked food	Method 1: The material ground with soaked rice and salt; thick paste covered or rolled in banana leaves and steam baked/cooked. Method 2: The material cut into small pieces and mixed with rice paste and steam baked by rolling in banana leaves.	Breakfast
Manni	Sweet	Seeds cooked and ground with jaggery; cooked with ghee to attain thick consistency.	Consumed with lunch
Melaara	Main curry	Material cooked with salt, turmeric powder and chilli powder; mixed with grated coconut and green chilli paste and boiled by addition of buttermilk; seasoned with mustard, red chilli and curry leaves.	Consumed along with rice
Menaskayi	Side dish	Material slightly fried and cooked with salt, turmeric powder, tamarind juice and jaggery; mixed with paste of grated coconut, sesame seeds and red chilli followed by boiling.	Sides for rice
Menasu bendi/Kalasu	Side dish	Material cooked along with soaked channa/seeds of Bengal gram by addition of salt, turmeric powder, jaggery and chilli powder; mixed and boiled with paste of grated coconut and cumin seeds; seasoned with mustard, red chilli and curry leaves.	Sides for rice
Ode	Snack	Material soaked in water or washed to remove extra salt; ground with a small quantity of soaked rice and grated coconut; paste was made into small spheres and pressed and fried in oil.	Snack especially during off season and can be stored for 15–20 days
Pakoda/ Poodi	Snack	Material cut into small pieces mixed with paste of gram flour, salt and chilli powder and fried in oil	Evening snack

Patrode	Steam-baked food	Material cut into small pieces, mixed with paste of rice, tamarind and spices; rolled in banana leaves and steam baked. Later it was consumed as it is or by shredding and seasoning with onion and green chilli (for spicy) or by mixing and seasoning with jaggery (for sweet).	Breakfast or snack
Payasa	Sweet	Material cut into small pieces and cooked with jaggery; later the coconut milk added and boiled; at the end cardamom powder was added and seasoned with cashew nuts and dry grapes.	Consumed with lunch
Perati/Berati	Sweet	Ripened perianths steam baked and ground with jaggary and cooked with ghee till attaining thick consistency.	Consumed with lunch; can be preserved up to one year; can be used to prepare a Payasa during off season
Saaru	Rasam	Material cooked with salt, turmeric powder, jaggery, crushed ginger and green chilli; seasoned with mustard, red chilli and curry leaves.	Consumed along with rice or soup
Santani	Snack	Seeds cooked with salt and sun-dried	Evening snack; can be preserved up to one year and used during rainy season
Suttavu	Sweet/Snack	Material cooked and ground with soaked rice along with little quantity of jaggery and fried in ghee.	Evening snack
Taalu/Palya	Side dish	Material cut into small pieces, cooked by addition of salt, chilli powder/green chilli and jaggery (tamarind juice added depending on requirement); seasoned with mustard, red chilli and curry leaves.	Sides for rice; used as sides for Chapatti, Rotti and Poori
Tambuli	Soup	Material fried/cooked and ground with grated coconut and cumin seeds; the paste was mixed with buttermilk	Sides for rice or soup
Undlakaalu	Snack	Material soaked in water or washed to remove extra salt; ground with a small quantity of soaked rice and grated coconut to thick consistency; small spheres are made by keeping small piece of coconut in middle and fried in oil.	Snack during off season; can be stored for 15–20 days

Sauropus androgynus

It is a green leafy perennial herb grows as weed in forests and in plantations. Mature plant produces small and dark maroon to purplish flowers and fades away subsequently. It also produces small star-shaped pinkish-purple fruits. Flowering and fruiting season is October to May.

Tender leaves are useful in preparation of several dishes like 'Saaru', 'Kodilu', 'Taalu'/'Palya', 'Chatni', 'Tambuli' and 'Patrode' (Table 2). The tender leaf has nutty taste and also eaten raw (Shubha *et al.,* 2011). Leaves serve as traditional vegetable in Thailand, Sri Lanka, Malaysia and Indonesia (Selvi *et al.,* 2011). Leaves are useful in enhancing milk secretion in lactating women and are also useful in relieving cough by soothing lungs (Petrus, 2013).

Syzygium caryophyllatum

It is a small evergreen tree grows up to 3–5 m tall, possess oval and glossy leaves. The flowers are small and white with numerous stamens. The fruits are small, round, green when young, become dark-purple, juicy on maturity and carries single seed. Flowering and fruiting season is March to August.

Tender leaves are also used to prepare 'Halakodi'/'Holakodi tambuli' (Table 2) and fruits are edible. The tender leaves are eaten raw as they cure oral ulcer and known to maintain blood sugar level in diabetic patients.

Leaves and stem

Basella alba

It is a cultivated leafy vegetable with climbing growth habitat. The leaves are fleshy, succulent, slimy, smooth, shiny and heart-shaped or ovate. The stem is green or purple-green, smooth, succulent and slimy. The fruits are purple. It can be cultivated throughout the year.

The leaves and stem are used in preparation of 'Kodilu' and 'Gasi' (Table 2). The leaves are also used to prepare 'Dose'. Tender leaves are useful to cure oral ulcer. They are also useful as folk medicine in curing different ailments (e.g. skin diseases, ulcers, anemia and sexual weakness) and serve as laxative in children and pregnant women (Adhikari *et al.,* 2012).

Talinum triangulare

It is an erect, small, fleshy herb grows up to 1 m height with succulent leaves and stem. It produces small pink flowers. It needs more watering for growth and flowers throughout the year.

Leaves and tender stem are used in the preparation of 'Saaru', 'Kodilu', 'Taalu'/'Palya' and 'Melaara' (Table 2). Leaves are also used in the preparation of 'Pakoda'/'Poodi' and 'Patrode'. Traditionally, the leaves are used to treat polyuria, internal heat, measles, gastrointestinal disorders, hepatic ailments and cancer (Swarna and Ravindhran, 2013).

Leaves and pods

Vigna unguiculata

It is a herbaceous climber possesses alternate trifoliate leaves. The flowers are creamish with bluish tinge. It produces slender smooth pods with many seeds. There are different varieties with different coloured pods (e.g., dark-green, light-green and purple). Flowering and fruiting occur throughout the year.

Leaves and pods are used in the preparation of different delicacies such as 'Taalu'/'Palya', 'Saaru', 'Kodilu' and 'Melaara' (Table 2). Sun-dried pod peel is soaked in salt water and administered orally to relieve cough in cattle. The roasted seeds are used to treat indigestion, insomnia, weakness, memory loss, neuritis, dyspepsia, sensation of pins or needles in limbs, cardiac failure, corneal ulcer, Kwashiorkor and marasmus (Battu *et al.*, 2011). The leaf decoction is used to treat hyperacidity, nausea and vomiting.

Leaves, flowers and fruits

Cucurbita moschata (Fig. 1e and f)

It is a cultivated, annual climber with broad, hairy and shiny leaves. It produces large and dark-yellow or yellowish-orange flowers. The fruits are giant, depressed globose, green when young and orange on maturity. Flowering and fruiting occur throughout the year.

Leaves are used in the preparation of 'Saaru', 'Kodilu' and ‘Taalu/Palya'; flowers are used in preparation of 'Chatni', 'Taalu'/'Palya' and 'Saaru' (Table 2). The fruits are used in the preparation of delicacies like 'Kodilu', 'Menasu bendi'/'Kalasu', 'Taalu'/'Palya', 'Payasa' and 'Kottige'. The paste of dried fruit

stalk along with turmeric is applied on the scorpion bitten region. The fruit stalk can also be sun-dried and stored for future use. The fruit is used to treat irritable bowel syndrome (IBS), for blood purification, leprosy, fatigue and muscle cramping (Kirtikar and Basu, 1935; Govindani *et al.,* 2012). It is also useful in curing hemorrhage of pulmonary organs, rheumatism and urinary infections (Govindani *et al.,* 2012).

Moringa oleifera

It is a small tree, branches out and grows up to 10 m height. The leaves are tripinnate with small and smooth leaflets. The flowers are white at first and turns into yellowish-cream on maturity. The fruits are green, triangular and bear winged seeds. The leaves, flowers and fruits possess pleasant flavour. Flowering and fruiting season is January to May.

Leaves, flowers and fruits are used to prepare 'Saaru', 'Kodilu', and 'Taalu'/'Palya' (Table 2). The dishes made out of *Moringa* are known to maintain blood sugar level in diabetic patients. The bark is used to treat cold and application of bark crush boiled in coconut oil cures runny nose as well as cold. Fried pods are used in diabetic, root juice as cardiac tonic and antiepileptic (Mishra *et al.* 2011). It is also used to treat nervous debility, asthma, enlarged liver/spleen, deep-seated inflammation and diuretics. Decoction is used to cure sore throat and cooked leaves are known to cure influenza.

Flowers

Hibiscus rosa-sinensis

It is an evergreen shrub, cultivated as an ornamental plant in homes gardens. The leaves are thick and dark-green. All parts of this plant produce slimy juice, flowers have a variety of colors and it flowers throughout the year.

Flowers of wild hibiscus (preferably red or white with 5 petals) are used in the preparation of 'Saaru' to keep the body cool (Table 2). The leaves and flowers are used in the preparation of 'Dose'. White flowers and buds are useful as mouth wash to cure oral ulcer. White flowers and buds are used in preparation of 'Rotti' to cure heat boils. The white flower bud paste mixed with buttermilk and administered orally during empty stomach to cure irregular menstrual cycle. The leaf extract is used to clean hair. The leaf paste mixed with cow's milk on oral administration (up to 5 days) is known to balance irregular menstrual cycles (Rajakumar and Shivanna, 2010). The leaves are also

used as remedy for fatigue and skin diseases; flowers are used to cure leprosy, epilepsy, bronchial problems and diabetes; the root juice is used to cure gonorrhoea (Kumar and Singh, 2012).

Flowers and fruits

Holarrhena pubescens

It is a small tree grows up to 3–8 m height, possesses medium size oval leaves. The flowers have five petals, white at first turns into creamish-yellow on maturity. Fruits are green and elongated. Flowers and fruits taste bitter. Flowering and fruiting season is March to October.

The dried flowers are used in to prepare 'Tambuli' and 'Saaru', while the fruits are used to prepare 'Taalu/Palya', 'Kodilu' and 'Menaskayi' (Table 2). 'Tambuli' made out of dried flowers helps to improve digestion and good for diabetic patients. The bark powder is applied twice a day up to 10 days to cure acute skin diseases (Rout *et al.,* 2009).

Bark and pods

Oroxylum indicum

It is a medium size tree grows up to 10–12 m height. Leaves are compound, smooth, opposite and triangle to oval. The flowers are large and reddish-purple with pinkish-purple interior. The plant produces long, flat, purplish-brown pods with many seeds. Pod resembles sword or elephant horn and seeds are light weight and papery. Flowering and fruiting season is May to August.

The bark is used in the preparation 'Tambuli', while tender pods are useful to prepare 'Taalu'/'Palya' (Table 2) and pickle. 'Tambuli' is known to cure diarrhoea. The bark decoction is used to cure gastric ulcer and the paste of bark is used against oral cancer and scabies. The mature fruits are used in cardiac disorders, gastropathy, cough, piles, jaundice, small pox, leucoderma, bronchitis and cholera (Warrier *et al.,* 1995; Joshi *et al.,* 2014).

Fruits

Artocarpus altilis

It is a wild evergreen tree species grows up to 12–15m tall, leaves are broad, leathery, shiny and deeply cut into pinnate lobes. All parts of tree yield milky latex. The compound immature fruit is green with hard white interior, starchy and fibrous. On ripening it becomes soft and interior becomes cream to light-yellow. It flowers twice in a year (June to September; November to February).

Raw fruits are used especially in the preparation of 'Kodilu', 'Dose', 'Taalu'/'Palya' and 'Pakoda'/'Poodi' (Table 2), chips and papad. Fruit peel is useful in preparation of 'Chatni'.

Averrhoa bilimbi (Fig. 1a)

It is a perennial tree reaches up to 10 m height. The main stem or trunk is divided into several branches. The leaf stalk is long consisting of 12–15 oppositely arranged leaflets. The plant produces bunches of purplish-pink flowers directly on the trunk or branches. The fruits are cylindrical, green, crispy when young, become soft and yellow on ripening. The fruit skin is glossy, shiny, smooth and thin. The flowers and fruits taste sour. Flowering and fruiting occur throughout the year.

The flowers, under-ripened/ripened fruits are sour and edible. The fruits are used to prepare 'Saaru' (Table 2) and pickle. The fruit powder is useful as an alternate to tamarind. The fruit is used to treat beriberi and cough; fruit syrup is used against fever, inflammation, rectal bleeding and to alleviate internal hemorrhoids; the leaf paste applied to cure itches, swelling of mumps and rheumatism (Roy *et al.*, 2011).

Averrhoa carambola (Fig. 1b)

It is a small evergreen tree grows up to 3–5 m height and rarely reaches 10 m. Leaves are alternate, small and smooth. The plant produces bunch of pinkish-purple flowers. Fruits are shiny, smooth, green when young and yellow on maturity. On cutting, fruit shows five partitions. Flowering and fruiting season is February to May.

Chopped raw or ripened fruits mixed with salt and chilli (or chilli powder) provide a ready to eat dish and the raw fruits are used to prepare pickle. The ripened fruits are used to prepare juice and 'Saaru' (Table 2). Fruits

also used to polish brass utensils/antiques. The oil extracted from fruit is useful to cure body pain and muscle catch. Mixture of equal volume of fruit extract and coconut oil, boiled, cooled, filtered to obtain yellow product, which serve as massage oil for curing body pains as well as muscle catch. Fruits are also used to treat toothache, oral ulcer, cough, asthma, food poisoning, skin rashes and jaundice (Das *et al.,* 2008; Dasgupta *et al.,* 2013).

Citrus aurantium (Fig. 1c and d)

It is a spiny evergreen tree cultivated in kitchen gardens. The leaves are smooth, shiny, glossy, medium size and oval. The flowers are white, fruits are round and having rough leathery surface, green when young and light yellow to orange-yellow on ripening. The fruits are similar to those of orange and possess sour/bitter taste. Flowering and fruiting season is August to March.

Raw fruits are used in the preparation of pickle. The fruit juice is used to prepare 'Chitraahnna', while the fruit peels are useful in preparation of 'Tambuli', 'Chatni' (Table 2) and 'Kashaya'. Salted fruit rind and peel with spices (cumin seeds, coriander seeds, black pepper and dry ginger) are crushed and boiled in water to prepare 'Kashaya' helps in digestion and cures cold. Traditionally, it is useful to treat different diseases like stomach ache, vomiting, blood pressure, cough, cold, bronchitis, earache, dysentery, diarrhoea, abdominal pain and fever (Karthikeyan and Karhikeyan, 2014).

Garcinia indica (Fig. 1g and h)

It is a large, evergreen tree with drooping branches and shiny leaves. It is indigenous to the Western Ghats and west coast of India. The flowers are solitary, fleshy and dark-pink. The fruits are dark-pink or brownish-pink consisting of 6–8 seeds with dark-pink or pinkish-white juicy pulp. The fruits are excellent in taste and aroma. Flowering and fruiting season is November to August.

The fruit and fruit peel is used in preparation of juice, squash and syrup. The dried fruit peel is useful in preparation of 'Saaru' and juice (Table 2). The fruit peel paste is used to maintain blood pressure. Fruit juice serves as an excellent appetizer, serves as liver tonic and helps to relieve sunstroke. In traditional Ayurvedic medicine, the fruits are used in curing skin ailments (e.g. allergic rashes, burns, scalds and chaffed skin), remedy for dysentery, diarrhoea, as cardiotonic, bleeding, piles, tumor and heart diseases (Mishra *et al.,* 2006).

Solanum torvum (Fig. 1k)

It is a small evergreen shrub, grows up to 5 m height. The leaves are broad and similar to those of brinjal. The stem, branches and leaves possess small thorns or prickles. The plant produces bunch of white flowers and small spherical fruits. The fruits are similar to baby brinjal, at first green and turns to yellow on maturity. Flowering and fruiting occur throughout the year, but yields more fruits during rainy season (June to November).

The fruits are used in the preparation of different delicacies like 'Saaru', 'Kodilu' and 'Gojju' (Table 2). The leaf extract is used to reduce body heat and unripe fruits are used to strengthen the body (Muthu *et al.*, 2006). The fruits and leaves are used in Cameroonian folk medicine (Jaiswal, 2012). Fruit decoction is used to treat cough and to treat liver and spleen enlargement (Siemonsma and Piluek, 1994; Jaiswal, 2012).

Fruits and seeds

Artocarpus heterophyllus

It is a large evergreen tree, wild in the Western Ghats/southwest coast of India and grows up to 8–25 m height. All parts of tree produce latex, leaves are alternate, glossy and leathery. Flowering and fruiting occur during December to July.

Tender as well as ripened fruits are edible. The perianth of raw jackfruit is used in the preparation of chips, 'Dose', papad and other dishes ('Kodilu', 'Gasi', 'Taalu'/'Palya' and pickle) (Table 2). The ripened perianth is used in the preparation of 'Dose', 'Kottige', 'Payasa', 'Genesale', 'Suttavu' 'Perati'/'Berati' and papad. The seeds are also used in preparation of 'Kodilu', 'Taalu'/'Palya', 'Gasi', 'Manni', 'Santani' and 'Holige'. During surplus yield, the ripened perianth cut into small pieces and seasoned with oil, mustard seeds, spices and salt, which serve as side dish/snack. The salted raw perianth is also used in the preparation of 'Undlakaalu'', 'Ode', chips, 'Taalu'/'Palya' and 'Rotti' (Table 2). The leaves are traditionally used for the preparation of 'Kotte' (container or cones of leaves). It is used as bowl to cook 'Idli', 'Kadubu'/'Kottige' (Bhagya *et al.*, 2013). The leaves are also used to cure skin diseases, wounds, boils and ulcers (Prakash *et al.*, 2009).

Discussion

Several benefits could be derived from the native or indigenous plant species for nutritional, nutraceutical and medicinal purposes. Southwest India is known for a variety of habitats rich in many native or wild plant species (e.g. mangroves, islands and coastal sand dunes) as potential source of food, fodder and pharmaceuticals (Shetty *et al*., 2002; Sridhar and Bhagya, 2007; Bhagya and Sridhar, 2009; Bhagya *et al*., 2013; Bhat, 2014; Karun *et al.*, 2014; Greeshma and Sridhar, 2016; Sridhar and Karun, 2016). Besides, traditionally maintained sacred groves (called 'Nagabana' or 'Devara Kaadu') are also common in southwest India, those are rich repository of a variety of plant species in their natural habitats.

The methods of preparation of different ethnic dishes using traditional plant sources are almost similar between Havyaka and Konkani. But the ingredients and spices used in preparation differ. In Konkani preparation use of garlic, pulses and soaked seeds are more compared to Havyaka. Many Konkani ethnic dishes are not prepared by Havyaka. For instance, a sweet called 'Manni' preparation is common in Konkani using seeds of *Artocarpus heterophyllus*, so also 'Dose' from the leaves of *Basella alba* and *Hibiscus rosa-sinensis.* Likewise, the mode of preparation of dish also varies between geographical locations (e.g. Mangalore and Kasaragod).

Many native plant species produce surplus amount of products, which cannot be used immediately and needs appropriate methods to preserve for its use during off season or during scarcity. Flowers of *Holarrhena pubescens* are sun-dried and stored in air-tight containers for preparation of 'Tambuli' and 'Saaru' during off season. The fruits of *Averrhoa bilimbi* are cut into small pieces and sun-dried, powdered and stored, which is useful as an alternate to tamarind. The oil extracted from fruits of *Averrhoa carambola* is stored for future use as massage oil. The fruit peels of *Citrus aurantium* are salted, sun-dried and stored for further use. Similarly, sun-dried fruit peel of *Garcinia indica* could be stored. The seeds and raw perianths of *Artocarpus heterophyllus* are stored for use during rainy season. The raw perianths are mixed with salt and stored in earthen containers. The seeds are dried and mixed with mud and preserved to avoid decay. Some of the ethnic delicacies are also preserved for some duration (see Table 2). Shelf life of some products can be extended by simple sun-drying, smoke-drying and salting. Some products can be pickled for long-term use. Besides, some products needs simple processing or appropriate mixing to use as cattle feed (during available and off season).

There is ample scope to develop industrial products from several native or indigenous plants. Potential examples of plant species discussed in this paper

include: starch-rich fruits of *Artocarps altilis*; starch-rich seeds and perianth of *Artocarpus heterophyllus*; iron-rich leaves/flowers/pods of *Moringa oleifera*; vitamin C-rich *Averrhoa bilimbi*; citric acid-rich *Citurs aurantium*; oxalic acid-rich *Averrhoa carambola*; hydroxycitric acid-rich rind and edible oil-rich seeds of *Garcinina indica*; edible oil-rich seeds of *Madhuca neriifolia*. In fact, breadfruits (*A. altilis*) are used for traditional fermentation in Pacific Islands, besides improving the nutritional value the product can be preserved for long duration (Labouisse, 2016). Similarly, wild jack or monkey jack (*Artocarpus hirsutus*) may become a major traditional source of food and cottage industry (Sarala and Krishnamurthy, 2014). Karun *et al.* (2014) discussed feasibility of wild fruits of the Western Ghats as industrial products.

Besides mere drawing attention of public on nutritional uses of many indigenous plant sources, evaluation of nutritional contents further strengthens use of such resources by tagging them with their important ingredients as well as geographic indication. Understanding additional benefits especially nutraceutical values of native or indigenous plant species are also important in disease resistance in different ethnic groups. Likewise, native or indigenous plant species are used as medicine other than edible purpose also needs more attention. Important aspects need to be addressed on native plants used as nutritional or nutraceutical source include: i) Which are the similar vegetables available in local markets? ii) What are the cost and benefit in comparison with similar vegetables? ii) How to increase such products and preserve for long-term use? iv) What are the feasibilities to use such produce for industrial scale? v) How such produce serve the food security of local population or ethnic groups?

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