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ORIGINAL PAPER

Bioinventory and documentation of traditional ecological knowledge of wild edible fruits of Kodagu-Western Ghats, India

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Abstract: Forty-five species of wild edible fruits were identified and traditional local knowledge of their usage was recorded in 40 villages of Kodagu district in Central Western Ghats, India one of the eight top hotspots of biodiversity in the world. We combined biodiversity inventory of trees with village interviews to record traditional ecological knowledge. Wild edible fruits were an opportunistic source of food for rural people. Wild edible fruits were rich in minerals, vitamins, carbohydrates, proteins, fats and fiber. In recent years there has been a decline in numbers of wild fruit trees due to changes in land use from uncultivated private wooded area to cardamom and coffee cultivation. The availability of wild edible fruits that were once very common on private cultivated areas has declined and their distributions are now restricted more to jungles and wildlife sanctuaries. We propose methods for conservation and describe the need for sustainable utilization to provide supplementary sources of nutritional and pharmaceutically useful edible wild fruits.

Keywords: wild edible fruits, nutraceutical, biodiversity, Kodagu, western Ghats.

Introduction

Kodagu is part of Western Ghats, of India recognized as one of the top hotspots of biodiversity in the world. It supports rich and endemic biodiversity which includes angiosperm and gymnosperm plants, microbes and macro fungi, and invertebrate and vertebrate fauna (Myers et al. 2000; Mohana et al. 2011). With over 1350 species of flowering plants, Kodagu one of the smallest districts, is home to 8% of India's and 35% of Karnataka's plant resources (Keshavamurthy and Yoga Narasimhan 1990). An important component of the flora is the diverse variety of wild edible plants that are used by native communities and include wild edible fruits. Wild edible fruits are the source of food for rural people. These wild edible fruits are rich in minerals, vitamins, carbohydrates, proteins, fats and fibre (Deshmukh and Waghmode 2011; Valvi et al. 2011a). Valvi et al. (2011b) studied the mineral content of wild edible fruits and showed that they are rich in nitrogen, phosphorus, potassium, calcium, magnesium, sodium, iron, zinc, copper and manganese. In addition to their basic nutritional value, these fruits often have both nutritional and pharmaceutical (nutraceutical) values reportedly providing health and/or medical benefits. They are used to treat various disorders, including intestinal ailments, diabetes, anaemia, bronchitis, asthma, cough, taxamia, diarrhea, cold, acidity, jaundice, cancer, calitis, hiccough, poisoning, dysphoea, and dysentery (Deshmukh and Waghmode 2011). Some wild fruits are good appetizers and digesters. Pickles, wine, jams, juice and salted fruits are the preserved products of wild edible fruits and are locally used and also popular among tourtists. Uthaiah (1994) reported more than 50 species of wild edible fruits from Kodagu.

In the last 30 years, due to changes in landuse and intensification of coffee cultivation, the density and diversity of trees has been reduced. Privately owned wooded areas were brought under cardamom and later coffee cultivation. The extent of area under Arabica coffee declined and that of Robusta coffee, which needs less shade, increased (Garcia et al. 2010). These changes resulted in retention of selected trees in coffee agroforestry systems. Large areas under natural forests owned and managed by the forest department were also converted to teak and other monocultural plantations. This led to the loss of many stands and/or species of native trees, including trees that yielded wild edible fruits. In this study, we identified 45 wild edible fruits that grew in coffee-based agroforestry plantations in 40 villages of Kodagu.

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We also recorded the rich traditional knowledge that the local communities hold on the usage of these fruits.

Methods

The bioinventory and documentation of wild edible fruits of Kodagu was undertaken by a CAFNET (Connecting, Enhancing and Sustaining Environmental Services and Market Values of Coffee Agroforestry in Central America, East Africa and India) project team in the two vegetation types, namely evergreen and moist deciduous vegetation. The study was carried out in/on coffee agroforests, sacred groves, and forests in 40 villages (Fig. 1) randomly selected in the district. We identified and counted trees in 120 coffee agroforests and recorded traditional ecological knowledge in coffee agroforests, sacred groves, and local forests as described by Poornika et al. (2011).

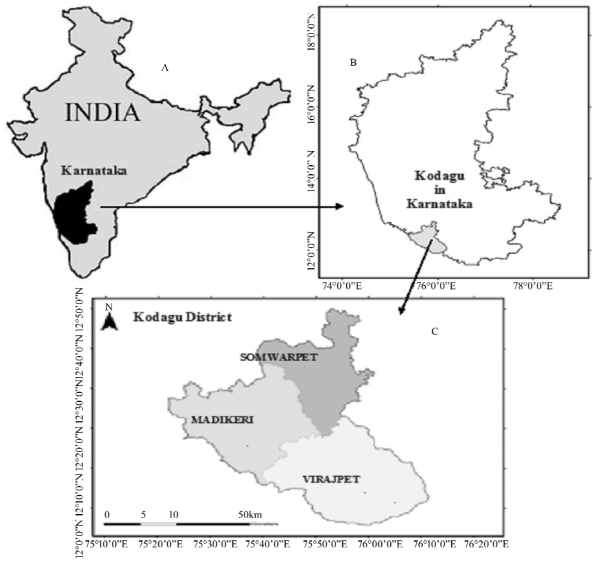

Fig. 1: Map showing the CAFNET research study area (A) Karnataka region in India (B) Kodagu district in Karnataka state (C) Three taluks of Kodagu district

The bioinventory of trees was undertaken using a variable width transect method (Sheil et al. 2002, 2003) in large, medium and small coffee agroforests (occasionally private unconverted jungles) at each village. We counted and identified 200 trees in each coffee agroforest and 600 trees in each village. Trees were identified using the 'Flora of Coorg' (Keshavamurthy and Yoga Narasimhan 1990) and 'A field key to the trees and lianas of the evergreen forests of Western Ghats' (Pascal and Ramesh 1987). Phenological data such as period of flowering and fruiting were based on the information collected by the project team and also from Flora of Coorg and earlier studies by Uthaiah (1994). These were verified by observations made by the farmers and the project team during the field inventory.

Traditional ecological knowledge in coffee agroforestry systems, sacred groves, and forests of Kodagu was documented by interviewing villagers. A total of 450 respondents including planters, managers, laborers (male and female), tree pruners, local tribes (Kodava, Gowda, Amma Kodava, Yarava, Kudiya, Iri, Jamma Mapalae, Peggade) and traders were interviewed. We recorded information on tree and shrub attributes, local and vernacular names, phenology and propagation methods, as well as fruit utility, occurrence, preparation and taste.

Observations and discussion

We recorded a total of 45 plant species that produced wild edible fruits in coffee agroforests, sacred groves, and forests from 40 villages of Kodagu. We classified these plants based on their vernacular name, scientific name, family, plant type, distribution and occurrence, uses, edible parts, fruiting season, culinary aspects and taste (Appendix 1). Of the 45 species, 3 were herbs, 7 were shrubs, 3 were creepers and 32 were trees.

Fifteen recorded species were common in coffee agroforestry systems. They had additional valuable qualities, including timber value, market value for fruits, high water retention in soil, and fast growth. Seven plants were rare in coffee agroforestry systems, 17 were restricted to evergreen forests and sacred grooves (very rarely found in young coffee agroforests), 3 were riparian and 3 species were common throughout the region and were not typically retained in coffee agroforests because they are thorny shrubs.

Most fruits were consumed fresh when ripe. The tender fruits used for pickling, salting and other culinary preparations were from *Artocarpus hirsutus*, *Artocarpus heterophyllus*, *Carissa carandas*, *Carissa spinarum*, *Phyllanthus emblica*, *Garcinia gummi-gutta*, *Mangifera indica*, *Margaritaria indica* and *Spondias pinnata.* Wine was made from *Syzygium cuminii, Carissa carandas*, *Carissa spinarum*, and *Phyllanthus emblica*. Fruits of medicinal importance were from *Chrysophyllum roxburghii*, *Carissa carandas*, *Carissa spinarum*, *Phyllanthus emblica, Garcinia gummi-gutta*, *Syzygium cuminii* and *Solanum americanum. Garcinia gummi-gutta*, locally called Ponpulli, yielded commercial quantities of fruits used for production of high value vinegar and also for extraction of Hydroxy Citric Acid (HCA) for manufacture of anti cholesterol medicines.

Uthaiah (1994) reported large populations of wild fruit-producing trees in the region in the early to mid 1990s and we noted that many such trees had been felled due to changes in land use. A large variety of trees, shrubs, creepers, lianas, scrubs and herbs were removed during the process of conversion from native forest to cultivation. Trees of choice are retained in coffee agroforestry with additional planting of exotic trees such as Silver Oak (*Grevelia robusta*), which could be cultivated and marketed free of restrictions on harvest and sale of native timber. This has resulted in loss of native trees of which wild edible trees are an important component.

Wild edible fruits are also an important source of food and nutrition to many species of birds, mammals, insects, flies, bees, wasps, ants and others. The seed dispersal of wild edible fruit is mainly carried out by birds and mammals while honey bees, wasps, ants, butterflies aid in pollination and, in turn, facilitate apiculture. Thus the presence of wild edible fruit plants in coffee

agroforestry systems helps to retain and conserve biodiversity.

The land which is converted to coffee is privately owned forest areas and not community or government owned forests. Hence farmers are not destroying resources of local villagers. The results of the study indicates that farmers as if now still retain many native fruit yielding trees, which helps in conservation of this important bioresource, but in future it will be a major challenge to retain these resources since farmers want to open the canopy and produce more coffee.

Conclusion

We recorded 45 different native wild edible fruit trees from coffee plantations in 40 villages and considerable local knowledge among farmers on the utility of these resources. 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. Studies on their nutraceutical values, efforts towards multiplication for distribution to farmers and value addition of the products are some actions which will help in bringing these trees back to cultivation.

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Appendix 1: Wild Edible Fruits of Coorg (Kodagu), Western Ghats, India

Scientific name	Family	Plant type	Fruiting season	Utility/preparations	Taste	Distribution and occurrence	Edible part
Aporusa lindleyana (Wt.) Bail.	Euphorbiaceae	Medium tree	May–Jun	1) Ripe fruits consumed fresh; 2) Fresh juice is made.	Bitter to sweet	All over Coorg. Common in Coffee agroforests.	Arils.
*Artocarpus gomezianus*Wall .ex Trecul	Moraceae	Medium tree	Dec–Jan	1) Ripe fruits consumed fresh; 2) Tender fruits are pickled; 3)Souring agent.	Sweet to sour	Evergreen, Rare.	Carpels.
Artocarpus Heterophyllus Lam.	Moraceae	Huge tree	Apr–Aug	1) Matured fruits consumed fresh; 2) Tender fruits are pickled and used in culinary preparation; 3) More than 40 preserved products are made.	Very sweet	All over Coorg. Common in Coffee agroforests.	Carpels and all other parts at different stages of development.
Artocarpus hirsutus Lam.	Moraceae	Huge tree	May–Jun	1) Ripe fruits consumed fresh; 2)Tender fruits are pickled; 3)Seed roasted and consumed.	Sweet to sour	Evergreen. Common in coffee agroforests	Carpels and seed.
Canarium strictum Roxb	Burseraceae	Huge tree	Jul–Aug	Inside kernel of hard stone	Almond like	Evergreen, Rare in coffee agroforests, red listed.	Inside kernel of hard stone

Continued Appendix 1:

Scientific name	Family	Plant type	Fruiting season	Utility/preparations	Taste	Distribution and occurrence	Edible part
Canthium coromandelicum (Burm.f.) Alston	Rubiaceae	Shrub	Apr–Jun	Ripe fruits consumed fresh	Sweet with slightly astringent blend	All over Coorg. Common. But not in Coffee agroforests.	Whole fruit except seed.
Carissa carandas L.	Apocynaceae	Thorny creeper	Apr- May/ Sep-Oct	1)Ripe fruits consumed fresh; 2) wine is made; 3)Tender fruits are pickled.	Sweet with the blend of latex	Evergreen; lowland. Rare (endangered).	Whole fruit except seed.
Carissa spinarum L.	Apocynaceae	Thorny creeper to lianas	Jun–Aug	1)Ripe fruits consumed fresh; 2) Wine is made; 3)Tender fruits are pickled.	Sweet with the blend of latex	Evergreen; highland. Rare (endangered).	Whole fruit except seed.
Catunaregum spinosa (Thumb.) Tirveng.	Rubiaceae	Small tree	Jun to Jul	Ripe fruits consumed fresh	Sweet and astringent.	All over Coorg. Common. But not in Coffee agroforests.	Whole fruit except seed.
Chrysophyllum roxburghii G.Don.	Sapotaceae	Huge tree	Mar–May	Ripe fruits consumed fresh	Sweet with the blend of latex	Evergreen. Rare in coffee agroforests (endangered).	Whole fruit except seed.
Citrus reticulata Blanco.	Rutaceae	Medium tree	Sep–Oct	Ripe fruits consumed fresh.	Sour to sweet	Evergreen; highland. Rare (endangered).	Carpels.
Cordia dichotoma G. Forst	Boraginaceae	Huge tree	Feb–Apr	Ripe fruits consumed fresh	Slightly astringent	Evergreen. Rare (endangered).	Whole fruit except seed.
Dimocarpus longan Lour.	Sapindaceae	Highly shaded huge tree	Aug–Nov	Ripe fruits consumed fresh.	Very sweet	Evergreen. Rare in young coffee agroforests.	Aril only.
Elaeagnus conferta Roxb	Elaeagnaceae	Thorny shrub	Jan–Mar	Ripe fruits consumed fresh	Sour to sweet	Evergreen. Rare.	Whole fruit except seed.
Elaeocarpus munroii Mast.	Elaeocarpaceae	Medium tree	Mar –Apr	Ripe fruits consumed fresh	Very sweet	Evergreen; shola. Rare.	Whole fruit except seed.
Epiprinus mallotiformis (Mull. Arg.) Croizat	Euphorbiaceae	Medium tree	Apr–Jun	Ripe fruits consumed fresh	Sweet to astringent	Evergreen. Frequent in coffee agroforests.	Whole fruit except seed.
Ficus callosa Willd.	Moraceae	Medium tree	Apr–May	1) Ripe fruits consumed fresh; 2) Pickling	Sweet to sour	Evergreen; highland. Rare.	Whole fruit.
Ficus racemosa Roxb.	Moraceae	Medium tree	All season	Ripe fruits consumed fresh	Sweet to astringent	All over. Common in coffee agroforests.	Whole fruit.
Flacourtia indica (Burm.f.)Merr.	Salicaceae	Thorny shrub to tree	Augt–Oct	Ripe fruits consumed fresh	Sweet	Evergreen. Rare in coffee agroforests.	Whole fruit except seed.
Flacourtia montana J.Graham.	Salicaceae	Small thorny tree	Dec–Feb	Ripe fruits consumed fresh	Sweet to sour	Evergreen; highland. Rare.	Whole fruit except seed.
Flueggea leucopyrus Willd.	Phyllanthaceae	Medium tree	Jun–Jul	Ripe fruits consumed fresh	Sour to bitter	Evergreen; highland. Rare (endangered).	Whole fruit except seed and rind.
Garcinia gummi-gutta (L.) Roxb.	Clusiaceae	Huge tree	Mar–May	1) Fruit and concentrated juice is used as souring agent; 2) Edible fat is extracted from seeds.	Sourish	Evergreen. Vulnerable globally. Common in coffee agroforests.	Whole fruit except seed.
Grewia tiliifolia Vahl.	Malvaceae	Medium tree	May–Jun	Ripe fruits consumed fresh	Sweet and slightly astringent.	Deciduous. Common in coffee agroforests.	Whole fruit except seed.
Lycopersicum esculentum Mill.	Solanaceae	Herb to creeper	Mar–May	Ripe fruits consumed fresh	Sweet and slightly astringent.	Common in coffee agroforestry only.	Whole fruit.

Continued Appendix 1:

Scientific name	Family	Plant type	Fruiting season	Utility/preparations	Taste	Distribution and occurrence	Edible part
Mangifera indica L.	Anacardiaceae	Huge tree	May–Jul	1) Ripe fruits consumed fresh; 2) 2)Tender fruits for pickle making; 3)Used for several culinary preparation; 4) stored in salt water for future use.	Sweet to slightly sour	Evergreen. Infrequent in coffee agro forests.	Whole fruit except seed.
Mangifera indica L.	Anacardiaceae	Huge tree	May–Jul	1) Tender fruit for pickle making; 2)Concentrated juice from whole fruit is used as souring agent.	Sourish	Evergreen. Besides river and streams.	Whole fruit except seed.
Margaritaria indica (Dalz.) A. Shaw	Phyllanthaceae	Medium to huge tree	Sep–Nov	1)Ripe fruits consumed fresh; 2) Pickle making.	Sweet to sour	Evergreen. Rare and endangered.	Outer pulp and inside kernel of seed.
Mimusops elengi L.	Sapotaceae	Medium to huge tree	Mar–May	Ripe fruits consumed fresh.	Sweet	Evergreen. Rare in coffee agroforests.	Whole fruit except seed.
Phoenix acaulis Roxb	Arecaceae	Palm	Dec–Feb	1) Ripe fruits consumed fresh; 2) sundried and preserved	Sweet	Evergreen. Very rare.	Whole fruit except seed.
Phyllanthus emblica L.	Phyllanthaceae	Huge tree	Jan–Apr	1)Ripe fruits consumed fresh; 2)Pickle making; 3)wine making.	Sour to highly bitter.(very small size)	Evergreen; highland. Rare (endangered).	Outer pulp and inside kernel of hard stone.
Psydrax dicoccos Gaertn.	Rubiaceae	Medium tree	Mar–May	Ripe fruits consumed fresh	Sweet	Evergreen. In higher elevation. Rare in coffee agroforests (endangered).	Whole fruit except seed.
Rourea minor (Gaertn.) Alston	Connaraceae	Small tree	Jul–Aug	Ripe fruits consumed fresh	Sourish	Evergreen; highland. Rare (endangered).	Whole fruit except seed.
Rubus ellipticus Sm.	Rosaceae	Thorny shrub	Feb–Apr	Ripe fruits consumed fresh	Sweet	Evergreen. Besides river and streams.	Whole fruit.
Scutia myrtina (Burm.f.) Kurz	Rhamnaceae	Thorny shrub	Jun – Aug	Ripe fruits consumed fresh	Astringent	Evergreen; Infrequent.	Whole fruit except seed.
Solanum americanum Mill.	Solanaceae	Herb	Throughout the year	Ripe fruits consumed fresh	Bitter to sweet	All over Coorg. Frequent in coffee agroforests.	Whole fruit.
Solanum oudepannum Dunal	Solanaceae	Thorny herb	Throughout the year	Ripe fruits consumed fresh	Sweet to astringent	All over Coorg. Frequent in coffee agroforests.	Whole fruit.
Spondias pinnata(L.f.) Kurz	Anacardiaceae	Small to medium tree	Jun–Aug	1)Ripe fruits consumed fresh; 2) pickle making.	Sourish	All over. Infrequent in coffee agroforests.	Whole fruit except seed.
Symplocos cochinchinensis ssp. Laurina (Retz.) Noot.	Symplocaceae	Medium tree	Sep–Nov	Ripe fruits consumed fresh	Sweet to astringent	Evergreen. Besides river and streams.	Whole fruit except seed.
Syzygium cuminii (L.) Skeels	Myrtaceae	Medium to huge tree.	Apr – May	1) Ripe fruits consumed fresh; 2) Wine making.3) Fruit juice-medicinal for diabetis	Sweet to slightly astringent.	All over Coorg. Common in coffee agroforests.	Whole fruit except seed.
Syzygium jambos (L.) Alston	Myrtaceae	Medium tree.	Nov–Jan	Ripe fruits consumed fresh	Sweet and crispy	All over Coorg. Infrequent in coffee agroforests and private jungle.	Whole fruit except seed.
Vateria indica L.	Dipterocarpaceae	Huge tree	Jun –Jul	Inside kernel of hard stone	Almond like	Evergreen. Rare in coffee agroforests (endangered).	Inside kernel of hard stone.
Tamarindus indica L.	caesalpinioideae	Huge tree	Dec–Jan	1)Ripe fruits consumed fresh; 2) Fruits are used as souring agents.	Sweet to sour	All over Coorg. Infrequent in coffee agroforests.	Whole fruit except seed.
Toddalia asiatica (L.) Lam.	Rutaceae	Thorny creeper	Oct –Dec	Ripe fruits consumed fresh	Sweet and very thick and flavoured.	Evergreen. Rare.	Pulp and rind.
Ziziphus oenopolia (L.) Mill	Rhamnaceae	Shrub	Dec–Jan	Ripe fruits consumed fresh	Very sweet	Evergreen. Rare.	Whole fruit except seed.
Ziziphus rugosa Lam.	Rhamnaceae	Thorny shrub	Feb– Mar	Ripe fruits consumed fresh	Sweet.	All over Coorg. Common. But not in Coffee agroforests.	Whole fruit Whole fruit except seed.

Notes: *They are taxonomically identical but different local varieties.