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ARTICLE

Collection and Conservation of Wild Edible Yams of Western Ghats

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Abstract

The Western Ghats which contain evergreen forests are rich sources of different species of edible yam species. They make significant contribution to the diets of tribal and poor people. In this study, exploration trips were conducted to different forest regions of Western Ghats (Wayanad, Kottur and Pechiparai) to collect and conserve different wild edible yams. A total of 1345 accessions of eight different species of wild *Dioscorea* were collected. The different species include *Dioscorea oppositifolia, D. pubera, D. wallichii, D. belophylla, D. bulbifera, D. hispida, D. pentaphylla* and *D. tomentosa*. The ethnobotanical study documented the local knowledge and potentials of these *Dioscorea* species.

Keywords:

Introduction

Yams form a group of several species of *Dioscorea* which are tuberous starchy food crops cultivated and consumed in the developing countries of the tropics as staple or subsidiary food. The principal edible yams cultivated in the world belong to 10 different species which are cultivated mainly in three different continents such as Asia, Africa and South America and also in the temperate regions (Lebot 2009). The most important edible yam is *D. rotundata* Poir. cultivated in Africa and two other species, *D. alata L.* and *D. esculenta* (Lour.) Burk., are cultivated in Asia and D. trifida in tropical America. Together they account for more than 95 per cent of the yams produced and eaten in the Tropics and provide staple food for the people in the developing countries of Africa, Asia, Caribbean, Melanesia and Polynesia. They are vegetatively propagated crops and the species are characterized by weak, climbing stems and underground tubers or rhizomes. Some species produce aerial tubers or bulbils also.

In India the three principal edible yam species cultivated are *D. alata* L., *D. esculenta* (Lour.) Burk. and *D. rotundata* Poir. The yam tubers are mostly eaten as a subsidiary food or vegetable rather than a staple food in India. They are popular throughout the country but their major cultivation and consumption are largely in the South and North Eastern states. In addition to the cultivated principal edible yams, a number of minor edible yams are also eaten by the tribal and poor people in almost every part of the country. The minor edible yams which are not yet domesticated are collected from the forests and wild habitats for consumption and sale in the village markets. The various wild edible yams (Dioscorea species) serve as a life saving plant group to marginal farmers and forest dwelling communities eespecially during periods of food scarcity (Arora and Pandey 1966). They are mainly starchy foods with essential dietary nutrients which make a significant contribution to the diets of the tribal and poor people.

Taxonomic explorers have reported about 50 yam species from the Indian subcontinent, mostly from the west, east and north eastern regions (Prain and Burkill 1938). From the southern peninsular India, 14 minor edible yam species are reported such as: *D. belophylla, D. bulbifera, D. glabra, D. hamiltonii, D. hispida, D. intermedia, D. kalkapershadii, D. oppositifolia, D. pentaphylla, D. pubera, D. spicata, D. tomentosa, D. wallichii* and *D. wightii* (Gamble 1928). D. vexans is another minor yam species collected from the Andamans and introduced to the mainland (Abraham et al. 2008). The Western Ghats which contain evergreen forests, moist deciduous forests, shoals and grasslands, abound with the minor edible yam species, which are collected and consumed by the tribal communities like the Kattunaikkas and Paniyas who have also developed folk taxonomy about the different yam species. Kattunaikka women have even attempted to introduce and domesticate some of the minor edible yam species from the forests as they are found to be palatable and nutritious (Balakrishnan et al. 2003). Published reports highlight about 19 wild edible yam species consumed by the local and tribal people of 13 states of India. Among the different states, the largest number of wild yam species is utilized in the state of Kerala where a dozen of them are consumed by the tribal people in the Wayanad district which contains part of the Western Ghats forests, where live the different communities of tribal people (Balakrishnan et al. 2003; Narayanan et al. 2011). In the literature there is no report of any kind about their flowering, floral morphology or floral biology which would help initiate hybridization and improvement of the species.

This study was aimed at collecting wild *Dioscorea* species and accessions from different regions of Western Ghats for

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studies on their general habits, agronomic traits and reproductive biology. Improvement by hybridization could eventually lead to ennobling many of those species for introduction into cultivation outside the tribal settlements, as important food crops. In the long run if suitable varieties could be developed, the minor edible yam species would hold considerable promise for supplementing the food baskets of the poor, in the context of the increasing food demand by the increasing population.

Materials and Methods

Exploration and Collection of Species

Exploration and collection trips were conducted in the forest areas of Western Ghats in Wayanad in the North Eastern part of Kerala, Kottur in the South Eastern part of Kerala in Thiruvananthapuram and Pechiparai in the Kanyakumari district of southern Tamil Nadu during November-December period. During the explorations the tubers as well as maturing fruits could be collected and sometimes leafy vines were also available for collection (Figs 1 and 2). Two collection trips were conducted to Wayanad, three trips to Kottur and four trips to Pechiparai. The collections were made in the form of tuber, fruit/seed, bulbils or vines which were stored separately in cloth bags with proper labels. Vines were stored in moist conditions to protect them from drying, for planting at an early date. The period of exploration lasted from 1day to 1 week. The collected accessions were planted in the experimental farm of the Central Tuber Crops Research Institute, Trivandrum. During the vegetative establishment, a large number of the accessions did not survive. From the surviving collections, samples were drawn from each species and planted separately.

The various collection sites in Wayanad lay between 76° 02′ to 76 ° 27′ East longitudes and 11° 35′ to 11° 51′ North latitudes. The collection sites in the Kottur reserve forest stretched between 77° 05′ to 77 ° 40′ East longitudes and 8° 20′ to 8° 50′ North latitudes. The collection sites of the Pechiparai forest areas lay between 77° 05′ to 77° 36′ East longitudes and 8° 03′ to 8° 35′ North latitudes. All three areas contained a rich diversity of plant species, especially the wild yam species employed in the present study.

Maintenance of Accessions

The collected accessions were initially grown in pots in the shade net house of Central Tuber Crops Research Institute (CTCRI), Trivandrum, with the vines trailed on coir ropes. Farm Yard Manure (FYM) was mixed with the potting mixture as manure and vermiculite was spread on top of the potting mixture to hold moisture. Male and female plants were trailed separately.

In the field the planting was done by the end of April after the pre-monsoon showers. Tuber cuttings were planted on mounds prepared at a spacing of 1m x 1m. During mound preparation, Farm Yard Manure (FYM) at the rate of 10 t ha-1 was applied to the soil. Fertilizers were applied at the rate of 80:60:80 kg ha-1 of N, P and K in two split doses as per the package of practices for yams. Weeding and earthing up were carried out along with each fertilizer application. The vines were supported on stakes of about 2 m height. Harvest was done during January–February by manually digging out the tubers and the tubers were cleaned free of soil and kept in a ventilated store house till the next planting season.

Results and Discussion

The largest number of 942 accessions of six wild edible yam species was collected from Wayanad. Another 327 accessions of six species were collected from Pechiparai. From Kottur 76 accessions of seven yam species were collected. In total 1345 accessions of eight wild edible yam species were collected from different sites of the three major areas of the Western Ghats forests (Table 1).

D. oppositifolia: *D. oppositifolia* is a right twining species (Fig.3). It occurs at the elevations of 2000-4000 ft in South India, Palani hills at 3000 ft, Cuttack district, Dhenkanal, Belgaum and Shimoga between 2000-3000 ft also (Prain and Burkill 1938). *D. oppositifolia* has good edible quality and market acceptability (Behra et al. 2010). This species is popular among the tribals, which is excellent and sweet in taste and eaten as such. They are seen predominantly in interior evergreen and moist deciduous forests and are rich in the 'podi' (starch) (Narayanan et al. 2011). The tubers of *D. oppositifolia* are also used as herbal tonic. It stimulates the stomach and spleen and has an effect on the lungs and kidneys. The tuber is good for the treatment of poor appetite, chronic diarrhoea, asthma, dry coughs, frequent or uncontrollable urination, diabetes and emotional instability. Externally, the tuber is applied to ulcers and boils. Leaf juice can be used to treat snake bites and scorpion stings (Poornima and Ravishanker 2007). The tubers are also used as an external application, after grinding and heating, to reduce swellings (CSIR 1952).

D. pubera: *D. pubera* is a right twining species (Fig.4). It occurs at the altitudes of 3000-5000 ft in the wet Himalaya and in forests under the mountains. In South India the species is distributed in Quilon and Malayattur. *D. pubera* occurs in different elevations in Jabalapur, Raipur, Ranchi, Devagiri at 600 ft, Khasi-Naga hills at 2000 ft (Prain and Burkill 1938). The tubers and bulbils of *D. pubera* are eaten fresh or in the form of liquid dishes. Some varieties emit an offensive odour when cooked (CSIR 1952). The species is very restricted in distribution, seen normally in the swampy forests in the interior wet and dry deciduous forests. The tribals use this species in making curry (Balakrishnan et al., 2003).

D. wallichii: *D. wallichii* is a right twining species (Fig. 5). In South India the species is known to occur in different places at different elevations in Wayanad, Mangalore, Nilgiri, Quilon, Gudulur at 3000 ft and Malayattur at 100 ft (Prain and Burkill 1938). It is found among way side bushes. The tuber is sweet, non sticky and used as curry/side dish and consumed as a source of carbohydrate. The tubers are highly fibrous in nature (rich in 'naru' - fibre) and consumed in the form of roasted dishes, for curing stomach disorders and constipation (Balakrishnan et al. 2003). Cooked tubers could be chewed and juice consumed for treatment of jaundice (Edison et al., 2006).

Table 1. Number of accessions of minor edible yam species collected.

Sl. No.	Species	Number of accessions collected from			Total
		Wayanad	Kottur	Pechiparai	
1	*D. oppositifolia*	141	8	73	222
2	*D. pubera*	..	10	..	10
3	*D. wallichii*	236	8	40	284
4	*D. belophylla*	5	..	..	5
5	*D. bulbifera*	217	32	61	310
6	*D. hispida*	..	5	14	19
7	*D. pentaphylla*	112	11	93	216
8	*D. tomentosa*	231	2	46	279
	Total	942	76	327	1345

D. belophylla: *D. belophylla* is a right twining species. Under the Himalaya it ascends to 5000 ft. In south India in Mangalore it occurs at sea level and is distributed in Nilgiri also. It also occurs at Jabalapur, Raipur, Godaveri, Devagiri at 2300 ft, Simla – below 5000 ft and Dehra Dun (Prain and Burkill, 1938). It grows very deep in the soil and is considered as the most delicious tuber which is consumed in the form of liquid dishes (Balakrishnan et al., 2003).

D.bulbifera: *D.bulbifera* is a left twining species (Fig. 6). It is a very widely spread species. It grows up to the elevations of 5000 ft. The species occurs in Malabar, Nilgiri hills, Cochin, Travancore (common up to 2000 ft), Gawhati, Simla at 4500-6000 ft, Dehra Dun at 1000-3000 ft, Nainital at 5500 ft, Darjeeling below 3000 ft, and abundant in South Andamans Port Blair (Prain and Burkill, 1936). *D. bulbifera* has the strongest free radical scavenging activity (Suriyavathana and Indupriya, 2011). It is cultivated for its bulbils which vary in their edibility. Some are consumed after cooking like potatoes in water with oil and local ingredients. Besides starch, bulbils contain other chemical agents such as protein, fats, fibres and minerals (Degras, 1986). In traditional Chinese medicine, *D. bulbifera* is used in the treatment of sore throat, gastric cancer and carcinoma of the rectum. The tubers are used mostly as famine food and for the preparation of starch. In Kashmir, the tubers are used for washing wool. Dried and pounded tubers are used as an application for ulcers, in piles, dysentery and syphilis. Bulbils of wild varieties are used as an application for sores (CSIR 1952). *D. bulbifera* is used by tribal ladies as contraceptive (Nashriyah et al., 2011). The tuber powder after mixing with butter is given to check diarrhoea.

D. hispida: *D. hispida* is a left twining species (Fig. 7). The species occurs at different elevations in Malabar, Travancore, Malayattur, Kallar, Thekkadi forest at 2000 ft, Darjeeling, Khasi- Naga hills between 2000 and 4000 ft (Prain and Burkill 1936). Among the wild yam species, *D. hispida* possesses good plant characters like limited vegetative growth, quick bulking, early maturing, shallow seated tuber, good colour and easy harvesting for an ideal yam cultivar. But the species is highly poisonous (Behera et al., 2010). The tuber flesh has yellow or white colour and a bit sticky. The species is used as food after detoxification. It is used in making traditional local food items, consumed with glutinous rice and grated coconut especially during breakfast. Fried tuber with salted fish is used for making edible flour after sun-drying. For making traditional medicine, detoxified tubers are first boiled with water, then the water used as a diabetes medicine, corm infuse used to decrease the blood glucose, the vines can be used for de-worming, and water of soaked yam used for eyes. In some parts of Asia this yam is used to prepare poison and the residue left after starch extraction used as insecticides (Nashriyah et al. 2011). The yellow juice is used for bleaching clothes. Tubers contain dioscorine (alkaloid responsible for poisonous nature) and are good sources of phosphorous, calcium and iron.

D. pentaphylla: *D. pentaphylla* is a left twining species (Fig. 8). It occurs throughout India ascending up to 5500 ft in the Himalayas and Andaman Islands. It occurs at Kottayam, Nilgiri, Travancore 100 ft, Thekkadi at 1800 ft, Kallar, Ariyankavu in open forests, Mundanthurai at 700 ft, Palani hills, Tanjore, Coimbatore, Thirunelveli, Anamali hills at 3000 ft, Salem, all over Mysore, Belgaum, Mahabaleshwar at 4500 ft, Jhansi, Lucknow, Jabalapur, Raipur, Bilaspur, Vizhakapatanam, Cuttack, Ranchi (Prain and Burkill, 1936). The species include poisononus and non-poisonous forms. The flowers are often collected and used as vegetables. Leaves are eaten in times of scarcity. Tubers are used to disperse swellings and as tonic (CSIR, 1952). *Dioscorea pentaphylla* is the most commonly consumed tuber. The tuber is single, less fibrous and is smooth pasty when cooked and tastes good. This variety is common on the fringes of deciduous forests (Narayanan et al., 2011). *D. pentaphylla* is an extremely widespread and variable species, such that Prain and Burkill recognized a total of 16 varieties in Asian species of *D. pentaphylla.*

D. tomentosa: *D. tomentosa* is a left twining species (Fig. 9). It is found to be distributed at different elevations in Malabar,

Figures 1-9. Figs.1 and 2. Collection sites at Wayanad and Pechiparai Fig. 3. *Dioscorea oppositifolia*. Fig. 4. *Dioscorea pubera*. Fig. 5. *Dioscorea wallichii*. Fig. 6. *Dioscorea bulbifera*. Fig. 7. *Dioscorea hispida*. Fig.8. *Dioscorea pentaphylla*. Fig. 9. *Dioscorea tomentosa*

Travancore at 3500 ft, Nilgiri hills, Gudalur at 3000 ft, Cochin, Parambikulam at 3000-4000 ft, Trichur, Quilon, at 100 ft, Malayattur, near Ponmudi at 2000 ft (Prain and Burkill, 1936). Due to the presence of thread like fibrovascular bundles the species is known as thread yam. Dioscorea tomentosa is not consumed regularly due to its high mucilaginous content, and is eaten only during times of acute famine. The species has the presence of a peculiar kind of fibre, which cause some irritation especially to children. This species is commonly seen in undisturbed forests (Balakrishnan et al., 2003).

Many different species and ecotypes of the minor edible yams are available in different forest areas. They are also becoming more important in the diets of the tribal people as some of the species are even brought into cultivation in the community settlements in the Wayanad district of Kerala State (Balakrishnan et al., 2003) as well as in the North Eastern State of Odisha (Behera et al., 2009b). The nutritional composition of several of the minor edible yams is reported to be comparable to that of the widely cultivated yam species (Behera et al., 2010). Several of those wild edible yams are found to have desirable traits such as anthracnose resistance, resistance to leaf spot disease and drought tolerance which are lacking in varieties of cultivated yams. In spite of the availability and occurrence of the minor edible yams outside the forests, there is no organized cultivation or popularization of those species for consumption, mainly because of the deep growing cylindrical tubers in most of the species. However no attempts were ever made to study the species regarding their reproductive biology with a view to hybridize them for genetic improvement.

During the exploration and collection trips for the present study in parts of the southern Western Ghats, the interactions with the tribal communities brought out the importance of the minor edible yams in their food habits. It was understood that a comprehensive picture of the utilization of the minor edible yams even in the few sites of collection for the present study, is not yet fully known to the outside world as there are no studies conducted at the grass root level. Perhaps the only detailed studies in this context are those conducted among the Kattunaikka people of Wayanad district by Balakrishnan et al. (2003) and Narayanan et al. (2011). Another study was the documentation of the extensive number of about 30 wild edible yam species used by the tribal people in Arunachal Pradesh, as the main source of sustenance (Saikia et al., 2011). From the exploration and collection trips undertaken for the present study it became evident that the published reports are not at all sufficient to bring out the true picture of the importance of the various minor edible yam species consumed by the tribal and poor people, the major localities where each species is popular and the intensity of its use by the people. The Western Ghats, being one of the hottest biodiversity hot spots is one of the richest habitats for the wild edible yam species (Prain and Burkill 1938, Gamble 1928), wherefrom a new yam species was recently discovered and named as *Dioscorea* longitubosa (Narayanan et al., 2010) which also forms a food of the Kattunaikka tribal people. It is likely that the Western Ghats might contain novel, undiscovered *Dioscorea* species as several unidentified Dioscorea species were often listed in the past reports of exploration and collection, (Velayudhan et al. 1998, Narayanan et al., 2011, Saikia et al., 2011).

Conclusions

The study revealed the habitat, collection period, conservation practises and uses of *Dioscorea* wild species. These plants are used mainly by the tribal and poor families as food. But further investigation is needed into the pharmacological properties of all these species.

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