



Genetic Resources of Root and Tuber Crops from North Cachar Hills of Assam

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Abstract

This paper documents 68 root and tuber crop genetic resources having edible, ornamental and medicinal values prevalent among the ethnic groups of North Cachar Hills (N. C. Hills) district (presently *Dima Hasao*) of Assam. A total of 14 types of yams, 32 types of aroids and 22 types of other root and tuber crops have been recorded during the present investigation. The study also documents the conservation strategies and traditional knowledge about the root and tuber crops collected from the ethnic groups of the district.

Key words: Phytoresources, North Cachar Hills, root and tuber crops, traditional knowledge, conservation

Introduction

Root and tuber crops are the energy reservoirs of nature mainly in the tropical regions. Due to the high starch content and calorie value, these crops have a major role in meeting the food security of marginal farmers and the ethnic people in the humid tropics. Root and tuber crops are tolerant to drought and flood and have wide adaptability to diverse agro-climatic conditions (Peter, 2008).

The ethnic people of the North Cachar district (presently *Dima Hasao* district) are largely secluded from other parts of the state due to poor road connectivity. The inhabitants of the district are largely tribal and mainly practice *Jhum* cultivation. Cereals like rice, maize, etc. produced in the *Jhum* lands are limited and a season's production is insufficient to meet the household need for the whole year. The edible roots and tubers, corms, rhizomes, etc. serve as supplementary food sources for the ethnic people of the district.

The genetic variation and taxonomy of root and tuber crops, especially the edible ones, have been studied in

different parts of the world including India (Plowman, 1969; Yen, 1974; Rao and Verma, 1969; 1975; 1976; Osche, 1977; Ghosh, et al. 1988; Mandal, 1993; Hore and Sharma, 1995; Reddy, et al., 1996; IPGRI/IITA, 1997; CTCRI, 2002; Scarcelli, et al., 2006).

The present work is a part of the study undertaken to explore and document plant resources of N.C. Hills, which still remains botanically unexplored. The objectives of the study were to record both wild and cultivated root and tuber crop genetic resources available in the area, to document the conservation strategies adopted by the ethnic groups inhabiting the district, to group the root and tuber crops based on agro-climatic conditions and uses and to document the traditional knowledge pertaining to the uses of the root and tuber crop resources prevalent among the ethnic groups of the district.

Materials and Methods

The study was conducted in the North Cachar Hills district, located in the southern part of Assam in India, which lies between 24°58' N and 25°47' N latitudes and 92°27' E and 93°43' E longitudes.

The germplasm of root and tuber crops was collected from different parts/localities of the district during 2007 to 2009. Passport data on each accession was recorded at the time of collection, following the standard NBPGR procedure. The edible yam and taro tubers /cormel samples were grown for one year in the Botanical Garden of Haflong Government College, Haflong and the mean yield per plant was recorded from three plants. A total of 32 root and tuber crops germplasm from the area of the present work, for which accession numbers were assigned, were submitted to National Bureau of Plant Genetic Resources (NBPGR) Regional Station, Meghalaya, India for multiplication and further conservation and their IC numbers are provided in Tables 1, 2 and 3. Rest of the collected specimens, without IC numbers were made into herbarium specimen following the methodology by Jain and Rao (1967) and later identified with the help of literature and comparison with the herbarium specimen at Herbarium of Botanical Survey of India, Eastern Circle, Shillong (ASSAM). The herbarium specimen was deposited at the Herbarium of Botany Department, Gauhati University (GUBH) for future reference.

Author's collection number, date and place of recording, botanical name, vernacular name(s), frequency, habitat, biological status (whether wild or cultivated), important features, mode of use and their local market value were recorded and are provided in Tables 1, 2 and 3.

The frequency of occurrence has been divided into abundant, frequent, occasional and rare, based on the availability of the living species recorded in the visited villages and its adjoining areas/forests which were considered as sampling unit/area. If a recorded species occurred in all the sampling area/unit, then it was considered as abundant. When a species occurred in most of the sampling area/unit but not in all, then it was recorded as frequent. It was considered occasional, when occurrence was limited to a few sampling units. When a species was found in one or a few sampling areas, then the species was considered as rare. Indigenous knowledge pertaining to these crops prevalent among the ethnic people was also recorded. The traditional harvesting techniques of the tuber or other plant parts for germplasm conservation practiced by the ethnic people of the district were also recorded. The root and tuber crop genetic resources were also grouped based on agro-climate and uses.

Table 1. Genetic resources of yams

Sl. no.	Collection number, date and place	Botanical name and Family	Vernacular name	Frequency	Habitat	Biological status	Important features, mode of use and fresh edible tuber yield per plant per year	Local market rate (Rs per kg of tuber)
1	PM-160/569100; 22-12-2008; Moulveng	<i>Dioscorea aculeata</i> L. Dioscoreaceae	Thagdi (DI), Barhtlum(HM)	Occasional	Climber	Semi-domesticated	Bark and flesh white, sweet tuber eaten boiled and also as vegetable The most preferred type for sweet taste, 1.76 kg	15
2	PM-156/569096; 18-12-2008; Choto Waphu	<i>Dioscorea alata</i> L. Dioscoreaceae	Thaphukhlong (DI), Banra (HR), Hereu (ZE)	Occasional	Climber	Semi-domesticated	Large tuber, red barked and flesh light purple, eaten cooked as vegetable and also mixed with rice, 3.35 kg	10
3	PM-157/569097; 18-12-2008; Choto Waphu	<i>Dioscorea alata</i> L. Dioscoreaceae	Baphu sathai (DI), Bahra (HM), Banra (HR), Baha (KU), Basa (MI)	Occasional	Climber	Semi-domesticated	Small tuber, bark and flesh white, eaten cooked as vegetable and also mixed with rice, 0.90 kg	10
4	PM-161/569101; 22-12-2008; Gunjung	<i>Dioscorea alata</i> L. Dioscoreaceae	Thayung (DI)	Occasional	Climber	Wild	Small long slender tuber, bark and flesh light purple, eaten cooked as vegetable. Tuber is also used as pig fodder; 0.65 kg	-
5	PM-162/569102; 28-12-2008; Dimalik Raji	<i>Dioscorea alata</i> L. Dioscoreaceae	Thaphu Bonglep (DI), Hereu (ZE)	Frequent	Climber	Cultivar	Large tuber, bark and flesh white, eaten cooked as vegetable and also mixed with rice, 1.68 kg	10

6	PM-163/569103; 05-01-2009; Gurubari	<i>Dioscorea alata</i> L. Dioscoreaceae	<i>Thaphu Gajao</i> (DI)	Frequent	Climber	Semi- domesticated	Large tuber, red barked and flesh light purple, eaten cooked as vegetable and also mixed with rice, 1.75 kg	10
7	PM-164/ 569104; 28-12-2008; Kana Basti	<i>Dioscorea alata</i> L. Dioscoreaceae	<i>Tarul</i> (NE), <i>Hnrutreu</i> (ZE)	Occasional	Climber	Cultivar	Large tuber, bark white and flesh light yellow, eaten cooked as vegetable and also mixed with rice, 1.45 kg	10
8	PM-439; 22-09-2008; Gurubari	<i>Dioscorea alata</i> L. Dioscoreaceae	<i>Hagrani thaphu- gidiba</i> (DI)	Frequent	Climber	Wild	Bark and flesh white, tuber is used as pig fodder. The soft tubers eaten cooked mixed with rice during food scarcity, 1.90 kg	-
9	PM-158/569098; 8-12-2008; Choto Waphu	<i>Dioscorea alata</i> L. Dioscoreaceae	<i>Thaphu miyung- wablai</i> (DI), <i>Basel phauk</i> (HM), Baha (MI)	Occasional	Climber	Semi domesticated	Smaller tuber, light red-purple bark and flesh eaten cooked as vegetable Tender shoots are crushed and rubbed on the wet hairs and skin to produce lather for bathing by ethnic people, 0.85 kg	10
10	PM-440; 07-12-2009; Sampharidisha	<i>Dioscorea bulbifera</i> L. Dioscoreaceae	<i>Thaphu-Hagrani</i> (DI)	Frequent	Climber	Wild	Bark and flesh white, tuber is mainly used as pig fodder, 1.70 kg	-
11	PM-165/ 569105; 22-12-2008; Gunjung	<i>Dioscorea orbiculata</i> Hook. f. Dioscoreaceae	<i>Thaphu-rhemim</i> (DI)	Frequent	Climber	Wild	Small long slender tuber, bark white and flesh light yellow, used as pig fodder and soft tuber eaten cooked as vegetable during food scarcity, 0.55 kg	-
12	PM-159/ 569099; 20-12-2008; Dikrik/Gurubari	<i>Dioscorea pentaphylla</i> L. Dioscoreaceae	<i>Thaphin</i> (DI), <i>Ram bahra</i> (HM), <i>Baha</i> (MI)	Occasional	Climber	Wild/Semi domesticated	Large oblong, bark white and flesh light yellow, cultivated soft tuber is cooked as vegetable. Wild type (Ram baha aling-HM/MI) contains more roots arising from tuber and the leaflets glabrous, used as pig fodder only. The cultivated type (Ram baha-HM/MI) contains fewer roots arising from tuber and the leaf lamina is hairy, 2.25 kg	-
13	PM-441; 22-12-2008; Gunjung	<i>Dioscorea villosa</i> Willd. ex Kunth Dioscoreaceae	<i>Thaphu-nairo</i> (DI)	Frequent	Climber	Wild	Medium tuber, light red-purple bark and flesh, mainly used as pig fodder. Sometimes soft tubers eaten cooked as vegetable, 0.70 kg	-
ii. Non-edible yam resources								
14	PM.-444; 22-12-2008; Gunjung	<i>Dioscorea hispida</i> Dennst. Dioscoreaceae	<i>Thadangja</i> (DI)	Rare	Creeper/ Climber	Wild	Small tuber, leaflet three, tuber and the seeds are known to have narcotic and even poisonous properties	-

*The fresh edible tuber yield per plant per year recorded is the average of three plants

Table 2. Genetic resources of aroids

i. Edible aroid resources									
Sl. no.	Collection number/ I.C.number, date and place	Botanical name and Family	Vernacular name	Frequency	Habitat	Biological status	Important features, mode of use and fresh edible tuber yield per plant per year	Local market rate (Rs.)	
1	PM-344; 07-12-2009; Sampharidisha	<i>Alocasia indica</i> (Roxb.) Schott Araceae	<i>Tha hagong</i> (DI)	Occasional	Herb	Cultivar	Fresh leaf sheath, tuber and stolon eaten cooked as vegetable, 0.65 kg	10/ bundle of leaf sheath and 500 g stolon	
2	PM-169/569109; 12-01-2009; Dibrari	<i>Alocasia macrorrhiza</i> (L.) G. Don Araceae	<i>Thagong yung</i> (DI), <i>Kebei</i> (ZE)	Occasional	Herb	Cultivar	Large, fresh or dried tuber eaten cooked with sour vegetable, 4.90 kg	10/kg of tuber	
3	PM-445; 07-12-2009; Sampharidisha	<i>Alocasia</i> sp. Araceae	<i>Midurangia</i> (DI)	Occasional	Herb	Wild	Fresh leaf sheath eaten cooked as vegetable, mostly preferred with dried fish	-	
4	PM-103/ 566687; 27-10-2008; Buolzol	<i>Alocasia</i> sp. Araceae	<i>Manai guphu</i> (DI)	Occasional	Herb	Cultivar	Fresh leaf sheath eaten cooked as vegetable	5/bundle of leaf sheath of about 500g	
5	PM-107/ 566691; 27-10-2008; Boro Waphu	<i>Amorphophallus bulbifera</i> (Roxb.) Bl. Araceae	<i>Thabema</i> (DI), <i>Saldong</i> (HM), <i>Telcong</i> (KU), <i>Teldon</i> (MI)	Occasional	Herb	Semi-domesticated	Tuber preferred to be eaten cooked with meat, 1.16 kg	10/kg of tuber	
6	PM-92/ 566676; 27-10-2008; Moulveng	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Balchin</i> (HM/MI)	Frequent	Herb	Jhum Cultivar	Fresh/dried leaf sheath/tuber eaten cooked as vegetable, 0.17 kg	-	
7	PM-93/ 566677; 27-10-2008; Moulveng	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Bahlip</i> (HM/MI)	Frequent	Herb	Wild	Fresh/dried leaf sheath/tuber eaten cooked as vegetable, 0.10 kg	-	
8	PM-94/ 566678; 27-10-2008; Boro Waphu	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Thakhtlong</i> (DI)	Frequent	Herb	Jhum Cultivar	Fresh/dried leaf sheath/tuber eaten cooked as vegetable, 0.55 kg	-	
9	PM-96/ 566680; 27-10-2008; Choto Waphu	<i>Colocasia esculenta</i> (L.) Schott, <i>Syn. C. antiquorum</i> Schott Araceae	<i>Thahon</i> (DI), <i>Kebei</i> (ZE)	Frequent	Herb	Jhum Cultivar	Fresh/dried leaf sheath/tuber eaten cooked as vegetable. Tubers boiled and used for preparing fermented chutney called Jaldong by Hmar women, 0.49 kg	10/100 g of chutney	
10	PM-97/ 566681; 27-10-2008; Boro Waphu	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Thadimai</i> (DI)	Frequent	Herb	Jhum Cultivar	Fresh leaf sheath/tuber/large stolon eaten cooked as vegetable, 0.48 kg	-	
11	PM-98/ 566682; 27-10-2008; Bouldora	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Balak pui</i> (HM/MI)	Frequent	Herb	Jhum Cultivar	Fresh/dried leaf sheath/tuber eaten cooked as vegetable, 0.30 kg	-	
12	PM-99/ 566683; 27-10-2008; Gurubari	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Thamadao</i> (DI)	Frequent	Herb	Jhum Cultivar	Fresh/dried leaf sheath/tuber eaten cooked as vegetable, 0.48 kg	-	

13	PM-100/ 566684; 27-10-2008; Boro Waphu	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Thadisa gajao</i> (DI)	Frequent	Herb	Jhum Cultivar	Fresh/dried leaf sheath and pink colored tuber eaten cooked as vegetable, 0.51 kg	10/kg of tuber
14	PM-101/ 566685; 27-10-2008; Boro Waphu	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Tha bongor</i> (DI)	Frequent	Herb	Jhum Cultivar	Fresh/dried leaf sheath and tuber eaten cooked as vegetable, 0.15 kg	-
15	PM-102/ 566686; 27-10-2008; Bouldora	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Balka</i> (MI), <i>Batta</i> (HR), <i>Mukhi</i> (NE)	Frequent	Herb	Jhum Cultivar	Fresh leaf sheath and tuber eaten cooked as vegetable, 0.30 kg	10/kg of tuber
16	PM-104/ 566688; 24-10-2008; Bulzol	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Bathalnik</i> (HR)	Frequent	Herb	Jhum Cultivar	Fresh blackish purple leaf sheath and stout tuber eaten cooked as vegetable, 0.46 kg	-
17	PM-105/ 566689; 24-10-2008; Bulzol	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Bathalnik</i> (HR)	Frequent	Herb	Jhum Cultivar	Fresh blackish purple leaf sheath and elongated tuber eaten cooked as vegetable, 0.35 kg.	-
18	PM-565; 20-12-2007; S. Muolkoi	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Dol</i> (HM), <i>Tha gisim hagrani</i> (DI)	Occasional	Herb	Wild	Petiole juice is applied locally to cure boils. The removed epidermis is used to bandage fresh cut wounds. Fresh leaf sheath and soft tubers harvested only during dry season are eaten cooked as vegetable, 0.15 kg	-
19	PM-446; 07-12-2009; Sampharidisha	<i>Colocasia</i> sp. Araceae	<i>Tha gondai</i> (DI)	Frequent	Herb	Wild	Fresh leaf sheath eaten cooked as vegetable	-
20	PM- 447; 13-12-2007; Hojai	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Thagong</i> (DI)	Occasional	Herb	Wild	Entire small plant eaten cooked as vegetable and also eaten raw as chutney with other spices, 0.05 kg	5/bundle of 500 g
21	PM-449; 13-12-2007; Hojai	<i>Colocasia esculenta</i> (L.) Schott Araceae	<i>Tha gisim hagrani</i> (DI), <i>Dol</i> (HM)	Occasional	Herb	Wild	Fresh leaf sheath and soft tubers harvested only during dry season and eaten cooked as vegetable, 0.06 kg	-
22	PM-168/ 569108; 12-01-2009; Dikrik	<i>Homalomena aromatica</i> Schott Araceae	<i>Tharem/ Thagong-yungsa</i> (DI)	Occasional	Herb	Semi domesticated	Fresh aromatic leaf sheath either eaten cooked or as chutney with chillies and spices	5/bundle of about 500 g leaf sheath
23	PM-170/ 569110; 12-01-2009; Dibarai	<i>Lasia spinosa</i> L. Araceae	<i>Shidabu/ Thathakhiao</i> (DI), <i>Changhrat</i> (HM)	Occasional	Herb	Wild	Tender leaf eaten cooked as vegetable	5/bundle of about 500 g leaf sheath
24	PM-95/ 566679; 27-10-2008; Moulveng	<i>Xanthosoma sagittifolium</i> (L.) Schott Araceae	<i>Dawl sel phauk</i> (HM), <i>Banai</i> (HR), <i>Dawl sialne</i> (MI)	Frequent	Herb	Cultivar	Fresh leaf sheath/tuber eaten cooked as vegetable, 0.35 kg	5/bundle of leaf sheath and 10/kg tuber
25	PM-91/ 566675; 27-10-2008; Longma-III	<i>Xanthosoma violaceum</i> (Vell.) Mansfeld. Araceae	<i>Manai gisim</i> (DI), <i>Dawl sel phak</i> (HM), <i>Banai</i> (HR), <i>Dawl sialne</i> (MI)	Frequent	Herb	Cultivar	Fresh leaf sheath/tuber eaten cooked as vegetable, 0.46 kg	5/bundle of leaf sheath and 10/kg tuber

26	PM-450; 22-09-2008; Buoizol	<i>Xanthosoma</i> sp. Araceae	<i>Dudh kochu</i> (NE), <i>Banai</i> (HR), <i>Dawl sialne</i> (MI)	Frequent	Herb	Cultivar	Fresh leaf sheath and tuber eaten cooked as vegetable, 0.62 kg	5/bundle of leaf sheath of about 500 g.	
ii. Medicinal and ornamental aroid resources									
27	PM-451; 16-12-2007; Choto Waphu	<i>Alocasia cucullata</i> Schott Araceae	<i>Tha-khashiba</i> <i>Hagrani</i> (DI)	Occasional	Herb	Wild	The plant is recorded to grow wild and managed as ornamental plant in the villages. Not edible	-	
28	PM-521; 25-10-2008; Buoizol	<i>Acorus calamus</i> L. Araceae	<i>Inamchek</i> (HR)	Occasional	Herb	Cultivar	Tuber/leaf paste is taken orally to cure gastric, but never consumed during pregnancy. Plant part is kept in the houses and also taken along with a person during journey in the hills to avoid evil spirits. Also kept in animal house to repel python	-	
29	PM-452; 07-12-2009; Sampharidisha	<i>Alocasia fornicata</i> Schott Araceae	<i>Tha gidiba</i> <i>Hagrani</i> (DI), <i>Dol thuang</i> (HR), <i>Baibing</i> (HM)	Occasional	Herb	Wild	The tuber paste is used as antidote medicine against snake and civet tiger bite by the <i>Hrangkhols</i> and <i>Dimasas</i> . Not edible. The tuber paste is applied locally on boils for early rupturing	-	
30	PM-453; 07-12-2009; Sampharidisha	<i>Aglaonema</i> sp. Araceae	<i>Hagrani Tha</i> (DI)	Occasional	Herb	Wild	The live plant is sometimes supplied to the local flower nurseries as ornamental plant	-	
31	PM-454; 16-12-2007; Choto Waphu	<i>Caladium</i> sp. Araceae	<i>Hagrani Tha gajao</i> (DI)	Occasional	Herb	Wild	The live plant is cultivated as ornamental plant	-	
32	PM-455; 07-12-2009; Sampharidisha	<i>Philodendron</i> <i>elegans</i> K.Krause Araceae	<i>Hagrani Tha lot</i> (DI), <i>Nahlam</i> (HM)	Occasional	Herb	Wild	The live plant is sometimes supplied to the local flower nurseries as ornamental money plant	-	

*The fresh edible tuber yield per plant per year recorded is the average of three plants

Results and Discussion

Agro-climate, soil and tribal population of the surveyed area

The elevation of the district ranges from 140 to 1866 m above mean sea level. Topographically, the N. C. Hills district can be mainly divided into:

- i. The hills of Borail Range or uplands covering the eastern and southern portions receiving considerably high precipitation
- ii. The valleys of Gunjung, Khorongma and Garampani located in the central part of the district and
- iii. The low lying areas in the valley of the rivers towards the northern part of the district - Diyung, Langting, Mahur, Jatinga and foot hills along Nagaon and Karbi Anglong district of Assam, where the precipitation is much lower

The average annual rainfall in the district, in general, ranged from 1454 mm to 4767 mm and was characterized by tropical humid conditions with average relative humidity ranging between 73% and 84%. The average mean temperature in the district during summer ranged between 24°C and 33°C and winter between 10°C and 14°C. However, in the hills, there was comparatively high rainfall and temperature fluctuated between 18°C and 22°C in summer and during winter the temperature declined to even below 5°C and

as a result the hills of the district have subtropical climate.

Soil texture of the district was sandy loam in the hills and sandy clay loam in the plains and valleys. Soil pH ranged between 4.1 and 6.2 and showed high organic C content, medium to poor P and medium to high K (Anonymous, 2002).

More than 70% of the district is comprised of the tribal population of which, the *Dimasas* constitute the largest ethnic group followed by the *Zeme Nagas*. The *Hmars* are the third largest ethnic groups in the District. The other ethnic groups of the District include *Hrangkhoh* and *Biates*, collectively known as the *Old-Kukis*; the *Jansens* and the *Thadous*, known as the *New-Kukis* and the *Sakacheps (Khelmas)* and *Vaipheis*, the smallest communities in the district.

Genetic resources of root and tuber crops

A total of 68 useful root and tuber crop genetic resources of edible, ornamental and medicinal value were recorded during the study and the results are discussed below.

Edible tubers or rhizomes and/or bulbils (Fig. 1a to g) of 14 types of yams (*Dioscorea* sp.) were recorded (Table 1). A total of 32 types of aroids that belong mostly to the genera *Colocasia*, *Alocasia*, *Xanthosoma* and *Amorphophallus* were recorded (Table 2). In addition to edible tubers, leaves and petioles of several species were used as vegetables. Some were grown as ornamental plants and a good number of species were used for treating a number of ailments. Variability in the *Colocasia* collection is shown in Fig. 2 a to o. A total of 22 types of other genetic resources of root and tuber crops (other than yams and aroids) were also recorded (Table 3).



Fig.1a. PM-157/569097



Fig.1b. PM-158/569098



Fig.1c. PM-163/569103



Fig.1d. PM-162/569102



Fig.1e.
PM-161/569101



Fig.1f. PM-164/569104

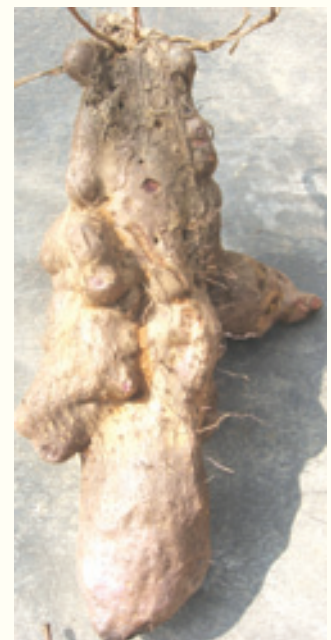


Fig.1g. PM-156/569096

Fig.1a to g. Variation in the edible tubers of *Dioscorea alata* L. at maturity, except Fig.1f, which shows tuber at the early stage of development



Fig.2a. PM-92/566676



Fig.2b. PM-102/566686



Fig.2c. PM-94/566678



Fig.2d. PM-96/566680



Fig.2e. PM-97/566681



Fig.2f. PM-98/566682



Fig.2g. PM-99/566683



Fig.2h. PM-100/566684



Fig.2i. PM-101/566685



Fig.2j. PM-447

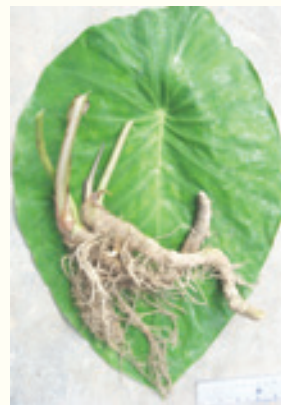


Fig.2k. PM-446



Fig.2l. PM-105/566689



Fig.2m. i. leaf and ii. tuber- PM-104/566688



Fig.2n. PM-93/566677



Fig.2o. PM-449

Fig.2 a to o. Variability in edible *C. esculenta* (L.) Schott. at maturity, except Fig.2b, e, f and n, which indicates early stage of development

Table 3. Other tuber and rhizomatous crop resources

i. Spices and condiments								
Sl. no	Collection number, I.C.number, date and place	Botanical name and Family	Vernacular name	Frequency	Habitat	Biological status	Important features, mode of use and fresh edible tuber yield per plant per year	Local market rate (Rs.)
1	PM-323; 07-12-2009; Sampharidisha	<i>Alpinia nigra</i> (Gaertn.) Burt Zingiberaceae	<i>Deragong</i> (DI), <i>Aihre don</i> (HM)	Abundant	Herb	Semi domesticated	Fresh soft pith and inflorescences used as vegetable and spice	5/ 250 g pith and five inflorescences
2	PM-324; 20-12-2007; Retzol	<i>Anomum maximum</i> Roxb. Zingiberaceae	<i>Aihere tel</i> (HM)	Rare	Herb	Semi domesticated	Crowded star shaped fruits arising from base used to prepare chutney with chillies	5/five fruits
3	PM-329; 07-12-2009; Sampharidisha	<i>Curcuma amada</i> Roxb. Zingiberaceae	<i>Thajju-hajing</i> (DI)	Frequent	Herb	Semi-domesticated	Fresh rhizome eaten raw as chutney	-
4	PM-484; 07-12-2009; Sampharidisha	<i>Curcuma domestica</i> Valet. Zingiberaceae	<i>Silik di</i> (DI), <i>Aieng</i> (HM/KU), <i>Ieng</i> (HR), <i>Gumnei</i> (ZE)	Frequent	Herb	Jhum Cultivar	Dried rhizome powder used in curry	15/100 g of powder
5	PM-489; 26-10-2008; Michidui	<i>Zingiber casumunar</i> Roxb. Zingiberaceae	<i>Naga Hajing</i> (DI), <i>Kaphu/ Kebeb</i> (ZE)	Occasional	Herb	Semi domesticated	Rhizome flesh light yellowish colored and used as spice for flavoring traditional chutney	-
6	PM-457; 26-10-2008; Michidui	<i>Zingiber officinale</i> Rose. Zingiberaceae	<i>Hajing</i> (DI), <i>Ai thing</i> (HM/HR), <i>Theing</i> (KU), <i>Kaphu/ Kebeb</i> (ZE)	Abundant	Herb	Jhum Cultivar	Rhizome/young inflorescences used as spice. Rhizome juice is mixed with lemon juice and taken orally to cure cough and also against indigestion problem	5/ 250 g of rhizome and handful of 10-12 inflorescences
ii. Edible and/or medicinal uses								
7	PM-559; 15-12-2007; Saisel	<i>Asparagus racemosus</i> Willd. Liliaceae	<i>Satmul</i> (NE), <i>Rum bahl</i> (HM)	Occasional	Climber	Semi-domesticated	Fasciculated root juice taken orally, once daily, early in the morning to control hypertension and dysentery Tender shoot eaten cooked with mixed vegetable	10/ bundle of 5-10 roots and 250 g of shoot
8	PM-567; 22-12-2008; Moulveng	<i>Costus speciosus</i> Sm. Zingiberaceae	<i>Simbu thut</i> (HM)	Frequent	Herb	Wild	Boiled rhizome water is taken orally daily in empty stomach to cure kidney stones	-
9	PM-568; 15-12-2007; S. Saisel	<i>Drynaria quersifolia</i> (L.) J. Sm. Drynariaceae	<i>Kupana thinga kop</i> (HM), <i>Nchew</i> (ZE)	Abundant	Epiphytic fern	Wild	Rhizome juice is applied to cure cut wounds. Rhizome is collected during dry season, cleaned, pounded, mixed with rice flour and baked into cakes by <i>Zeme Nagas</i>	-

10	PM-442; 22-12-2008; Moulweng	<i>Stemona tuberosa</i> Lour. Stemonaceae	<i>Basel phauk</i> (HM)	Rare	Climber	Semi domesticated	Smaller tuber, hard thorns at stem base, bark and flesh white, tuber eaten cooked as vegetable, 0.56 kg	-	
11	PM-167/ 569107; 22-12-2008; Dikrik	<i>Smilax china</i> Maxim. Smilacaceae	<i>Susni</i> (DI), <i>Jun se-pi</i> (HR), <i>Reucheu</i> (ZE)	Occasional	Climber	Wild	Smaller tuber, bark and flesh white, stock of the boiled tuber taken orally daily early in the morning as revitalizing tonic, 0.15 kg	20	
12	PM-166/ 569106; 22-12-2008; Gunjung	<i>Smilax glabra</i> Roxb. Smilacaceae	<i>Thassap</i> (DI), <i>Jun se-pi</i> (HR), <i>Reucheu</i> (ZE)	Occasional	Climber	Wild	Small tuber, bark and flesh white, tuber eaten cooked as vegetable, 0.25 kg	-	
13	PM-443; 21-12-2007; Longma-III	<i>Stephania glandulifera</i> Miers. Menispermaceae	<i>Shidigubru</i> (DI), <i>Jun se-pi</i> (HR)	Frequent	Climber	Wild	Cooked rice in a fresh leaf plate is given to children, for recovering from bed- wetting by the <i>Dimasas</i> and the <i>Hrangkhols</i> .	-	
14	PM- 554; 07-12-2009; Sampharidisha	<i>Zingiber zerumbet</i> (L.) Rosc. ex Smith Zingiberaceae	<i>Hajing gidiba</i> (DI), <i>Gawang</i> (ZE)	Frequent	Herb	Semi domesticated	Rhizome paste is applied locally to cure acute ruptured boils on human body	-	
iii. Edible and/or material uses									
15	PM-84/ 560841; 21-12-2007; Muolkoi	<i>Canna edulis</i> Ker- Gawl. Cannaceae	<i>Par baul Phauk</i> (HM), <i>Nung gum</i> (ZE)	Occasional	Herb	Cultivar	Rhizome eaten cooked as vegetable	-	
16	PM-348; 22-09-2008; Gurubari	<i>Ipomoea batatas</i> (L.) Lamk. Convolvulaceae	<i>Thamunglai guphu</i> (DI), <i>Kolkai</i> (HM), <i>Gaithum</i> (MI), <i>Reukumbe</i> (ZE)	Frequent	Creepers	Cultivar	White barked tuber, eaten boiled	10/kg of tuber	
17	PM-652; 20-12-2007; Muolkoi	<i>Ipomoea batatas</i> (L.) Lamk. Convolvulaceae	<i>Thamunglai Gajao</i> (DI), <i>Kolkai</i> (HM), <i>Gaithum</i> (MI), <i>Reukumbe</i> (ZE)	Frequent	Creepers	Cultivar	Red barked tuber, eaten boiled. The fresh peeled and crushed tuber paste is applied to rejuvenate skin	10/kg of tuber	
18	PM-668; 07-12-2009; Sampharidisha	<i>Kaempferia rotunda</i> L. Zingiberaceae	<i>Sitkidi bakhor- gisim</i> (DI)	Rare	Herb	Wild	Rhizome paste imparts black colored traditional dye that is used to dye cotton fiber	-	
19	PM-250; 16-12-2007; Choto Waphu	<i>Manihot esculenta</i> Crantz, Syn. <i>M. utilissima</i> Pohl. Euphorbiaceae	<i>Ruthi</i> (DI), <i>Thing kowlkai</i> (HM), <i>Ba thing</i> (HR)	Frequent	Under shrub	Cultivar	White and pink tuber flesh coloured types were recorded to be eaten boiled or raw. The leaves are used for traditional rearing of Eri silkworms (<i>Samia ricini</i> Donovan) as substitute of <i>Ricinus communis</i> L. (Euphorbiaceae) leaves	10/kg of tuber	
20	PM-351; 22-09-2008; Gurubari	<i>Maranta arundinacea</i> L. Marantaceae	<i>Tha Lairusa</i> (DI), <i>Hnathel</i> (HM), <i>Hpogimbai</i> (ZE)	Occasional	Herb	Cultivar	White coloured tuber eaten boiled or raw. Two cups of tuber juice taken orally early in the morning until curing of jaundice	10/kg of tuber	

21	PM-352; 20-12-2007; Boro Waphu	<i>Maranta dichotoma</i> L. Marantaceae	<i>Tha Lairu</i> (DI), <i>Hnathel</i> (HM), <i>Hpogimbai</i> (ZE)	Occasional	Herb	Cultivar	White coloured tuber eaten boiled or raw	10/kg of tuber
22	PM-456; 25-12-2007; Khuonghuong	<i>Pachyrrhizus</i> <i>erosus</i> Rich. Fabaceae	<i>Sbai kalendre</i> (DI), <i>Usulbe</i> (HM/KU)	Rare	Climber	Cultivar	Underground tuber and seeds eaten cooked as vegetable	-

Abbreviations indicating the ethnic communities: (BI)-Biatac, (DI)-Dimasa, (HM)-Hmar, (HR)-Hrangkhoh, (KU)-Kuki, (MI)-Mizo, (NE)-Nepali, (ZE)-Zeme Naga

*The fresh edible tuber yield per plant per year recorded is the average of three plants

Present investigation revealed that most of the tuber, corm and rhizome of the plant resources were used for edible purposes, eaten either cooked or raw. Some of the species were used for both edible and/or for medicinal purposes. These had other uses too. Based on some of the specific uses, these phytoresources were categorized as: spices and condiments, edible and/or medicinal uses, edible and/or material uses and ornamental (Table 3).

Grouping of genetic resources of root and tubers based on uses

Spices and condiments: *Alpinia nigra* (PM-323), *Amomum maximum* (PM-324), *Curcuma amada* (PM-329), *C. domestica* (PM-484), *Zingiber casumunar* (PM-489) and *Z. officinale* (PM-457).

Edible and/or medicinal uses: *Acorus calamus* (PM-521), *Alocasia fornicata* (PM-452), *Asparagus racemosus* (PM-559), *Colocasia esculenta* (PM-565), *Costus speciosus* (PM-567), *Drynaria quersifolia* (PM-568), *Stemona tuberosa* (PM-442), *Smilax china* (PM-167), *Stephania glandulifera* (PM-443), *Zingiber officinale* (PM-457) and *Z. zerumbet* (PM-554).

Edible and/or material uses: *Dioscorea alata* (PM-158), *D. hispida* (PM-444), *Canna edulis* (PM-84), *Ipomoea batatas* (PM-348 and 652), *Kaempferia rotunda* (PM-668), *Manihot esculenta* (PM-250), *Maranta arundinacea* (PM-351), *M. dichotoma* (PM-352), *Pachyrrhizus erosus* (PM-456). The leaves of *Manihot esculenta* was used for rearing of *Eri* silkworms (*Samia ricini* Donovan) as a substitute for *Ricinus communis* L. (Euphorbiaceae) leaves.

Ornamental: *Aglaonema* sp. (PM-453), *Alocasia cucullata* (PM-451), *Caladium* sp. (PM-454) and *Philodendron elegans* (PM-455).

Grouping of root and tuber crops based on agro-climate

Agroclimatically, the recorded root and tuber crops from the district have been categorized as follows:

Root and tubers grown in upland: *Alocasia* sp. (PM-445), *Alpinia nigra* (PM-323), *Amomum maximum* (PM-324), *Colocasia esculenta* (PM-92, 94, 96 to 101, 104, 105 and 446), *Dioscorea aculeata* (PM-160), *D. alata* (PM-156, 157, 439 and 158), *D. orbiculata* (PM-165), *D. hispida* (PM-444), *Kaempferia rotunda* (PM-668), *Smilax china* (PM-167), *S. glabra* (PM-166), *Stemona tuberosa* (PM-442), *Zingiber zerumbet* (PM-554).

Root and tubers grown in upland, lowland and valleys: *Acorus calamus* (PM-521), *Aglaonema* sp. (PM-453), *Alocasia* sp. (PM-103), *Alocasia cucullata* (PM-451), *A. fornicata* (PM-452), *Amorphophallus bulbifera* (PM-107), *Asparagus racemosus* (PM-559), *Caladium* sp. (PM-454), *Canna edulis* (PM-84), *Colocasia esculenta* (PM-93, 102 and 447), *Costus speciosus* (PM-567), *Curcuma amada* (PM-329), *C. domestica* (PM-484), *Dioscorea alata* (PM-161 to 164 and 440), *D. pentaphylla* (PM-159), *D. villosa* (PM-441), *Drynaria quersifolia* (PM-568), *Homalomena aromatica* (PM-168), *Ipomoea batatas* (PM-348 and 652), *Manihot esculenta* (PM-250), *Maranta arundinacea* (PM-351), *M. dichotoma* (PM-352), *Pachyrrhizus erosus* (PM-456), *Philodendron elegans* (PM-455), *Stephania glandulifera* (PM-443), *Xanthosoma violaceum* (PM-91), *X. sagittifolium* (PM-95), *Zingiber casumunar* (PM-489), *Z. officinale* (PM-457).

Roots and tuber crops grown in lowland and valleys: *Alocasia indica* (PM-344), *A. macrorrhiza* (PM-169), *Colocasia esculenta* (PM-449), *Lasia spinosa* (PM-170).

Conservation of genetic resources of root and tuber crops

Most of the root, tuber and rhizomatous crops collected for consumption by the ethnic people were wild. Instead of going to the forest for collecting these plant resources or for easy access, they were grown in the *Jhum* as well as in the homestead area. Thus, some of the selected and desired types were recorded as semi-domesticated in the present study. This traditional practice of plant domestication helps in better crop management and food security of the ethnic people in the area. A total of 15 such semi-domesticated species recorded were – *Alpinia nigra* (PM-323), *Amomum maximum* (PM-324), *Amorphophallus bulbifera* (PM-107), *Asparagus racemosus* (PM-345), *Curcuma amada* (PM-329), *Dioscorea aculeata* (PM-160), *D. alata* (PM- 156, 157, 158/651 and 163), *D. pentaphylla* (PM-159), *Homalomena aromatica* (PM-168), *Stemona tuberosa* (PM-442), *Zingiber casumunar* (PM-489) and *Z. zerumbet* (PM- 554).

Edible root and tuber crop genetic resources were the most important sources of carbohydrate next to rice and other cereals for the ethnic groups of N.C. Hills of Assam. Since time immemorial the ethnic groups of the hills have been managing the root and tuber crops in such a way that these helped them during food scarcity in certain period(s) of the year. When all the rice stock got exhausted, they started mixing rice with the tubers to supplement the source of carbohydrate. The unpalatable fibrous portion of these root and tubers were also used as pig feeds.

The harvesting technique of the soft edible yam tubers by the ethnic groups can be considered as a significant plant genetic resource conservation technique. Instead of uprooting the whole tuber, they harvest only the soft portion of the larger and elongated tuber by digging a hole in the ground. Thus, the upper hard and unpalatable part of the tuber was left behind for maintaining the germplasm stock.

Generally, in the case of aroids, the ethnic people collected the soft tuber buds / stolons, while the main tubers were left behind. They collected the main tubers

only during food scarcity. Some of them were even grown in a preferred place like *Jhum* field or homestead area / vicinity of the village.

The large stolon / soft tuber buds and fresh fleshy leaf sheath of the *Colocasia esculenta* (PM-96, 97 and 100) were preferably harvested to be eaten cooked but the main tuber was left behind for regeneration.

The fresh leaf sheath of *Homalomena aromatica* (PM-168), *Lasia spinosa* (PM-170), *Xanthosoma* sp. (PM-450), *X. violaceum* (PM-91), *X. sagittifolium* (PM-95) were preferred to be eaten as *chutney* or cooked as vegetable. So, during harvest, the fresh leaf sheaths were carefully removed and at least three leaves of the live plant were left behind for further growth and maintenance of the plant.

The tubers of *Dioscorea alata* (PM-157 and 158) and other tuber crops like *Asparagus racemosus* (PM-559), *Stemona tuberosa* (PM-442), *Smilax china* (PM-167) and *S. glabra* (PM-166) were smaller in size and one or two tubers were left behind after harvest. Again, only half of the tuber and leaves of *Manihot esculenta* (PM-250) were collected for use instead of uprooting the whole plant for early regeneration.

Further scientific investigation covering different aspects of these plant genetic resources is expected to provide newer or additional germplasm for improvement of our existing root and tuber crop genetic resources.

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