

Horticultural diversity in North-East India and its improvement for value addition

Bidyut C. Deka*, A. Thirugnanavel, R. K. Patel¹, Amit Nath¹ and Nishanth Deshmukh¹

ICAR Research Complex for NEH Region, Jharnapani, Nagaland

¹ICAR Research Complex for NEH Region, Barapani, Meghalaya

Abstract

Northeast India is known for its diverse nature of soil, climate, and topography. This region is rich in diversity of many fruits, vegetables, flowers particularly orchids, spices, bamboo and medicinal & aromatic plants. Among the commercial fruits of the country, maximum diversity in citrus, banana and jack fruit are found in Northeast India. A large number of diversity in other tropical and subtropical fruits belonging to the genera *Garcinia*, *Artocarpus*, *Phyllanthus*, *Annona*, *Averrhoa*, *Persia*, *Aegle*, *Passiflora* and *Tamarindus* etc. are reported from the region. Northeast India is also rich in different genotypes of cucurbits, solanaceous vegetables, ginger, turmeric, bamboo, leafy vegetables etc. Among the different ornamental horticultural crops, the region has the maximum diversity in orchids, fern and other flowering shrubs. Indigenous and minor horticultural crops available in the region are however not being exploited properly. These crops have the potentiality to alleviate the poverty, food and nutritional insecurity through processing and value addition. Most of these crops are rich in vitamins, minerals and such other bioactive molecules suitable for medicine, aromatic and food processing industries. Protocols for preparation of instant ginger candy; minimally processed ready-to-cook jack fruit; jam-jelly, fermented and non fermented beverages from different indigenous fruits and tuity fruity from chow-chow have already been standardized. These value added products if produced commercially will go a long way in increasing the area under these crops and thereby enhancing farm income and nutritional security of the farmers.

Key words: Biodiversity, Northeast, value addition, improvement

Introduction

North East India comprises of eight states viz., Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Mizoram, Nagaland and Sikkim. The total area of North East occupies 7.7 per cent of India's total geographic area supporting 50 per cent of the

biodiversity in the country [1], of which 31.58 per cent is endemic. It is one of the hot spot [2] in India, known for its diverse nature of soil, climate, and topography. This region is rich in diversity of many fruits, vegetables, flowers particularly orchids, spices and medicinal plants. Apart from the commercial crops, most of the indigenous crops are rich in vitamins, and minerals and they are not properly exploited.

Conservation and utilization of the existing genetic diversity under the present situation of climate change, depletion of natural resources, faulty agro techniques (*Jhum* cultivation) and increasing demand on the limited resources are the major challenges for the scientists, planners and policy makers. Many more efforts are required for exploring the unexplored areas for collection of horticultural biodiversity wealth. Plant genetic resources are our heritage which needs conservation for posterity. PPV &FRA may play a crucial role in protecting these unexplored germplasm of the region for future use.

Diversity of horticultural crops in Northeast India

The horticultural crops grown in this region range from tropical and sub-tropical to temperate fruits, vegetables and flowers both indigenous and introduced crops. Tuber and rhizomatous crops like sweet potato, colocasia, ginger and turmeric grow abundantly, while plantation crops like cashew nut, black pepper have been introduced recently. Apart from these, underutilized crops like passion fruit, kiwi fruit, chow-chow and others are grown in some areas.

Fruit crops

Northeast India is the citrus depository of our country where many citrus species are originated. *Khasi* mandarin (*Citrus reticulata*) is widely cultivated in

*Corresponding author's e-mail: bidyutdeka@yahoo.com

Northeast India and Sweet orange (*Citrus sinensis*) is also commercially grown in some of the places in the region. Apart from the most commonly cultivated species *Citrus indica* Tanaka (Indian wild orange), *C. latipes* (Swingle), *C. ichangensis* Swingle (Ichang Papeda), *C. medica*, *Citrus assamensis*, *Citrus macroptera* and *C. hystrix* were reported to occur in the subtropical forests of North-East India and the foot hills of the East Himalayas [3-6].

Maximum genetic variability of *Musa acuminata* and *M. balbisiana* occurs in NE India. *M. flaviflora* is localized to Manipur and Meghalaya. National Bureau of Plant Genetic Resources (NBPGR) in 1986 collected some of the important land races of banana (Seeded Ladiarit and Ladison, Rigitchi and other elite types, Hatigola, Eboke, Ginde, Egitchi and Essing) from Meghalaya. There are other species found in Khasi Hills, which need systematic collection and conservation. Rich diversity occurs in *Pyrus*, *Rubus*, *Ribes* and *Prunus*. The Shillong plateau of Khasi hills in Meghalaya have many *Prunus* species such as *P. nepalensis*, *P. undulata* and *P. cerasoides*. *Pyrus pyrifolia* var. cubha makai (*P. serotina* Red) and some of them are grown semi commercially in Meghalaya.

A large number of other tropical and subtropical fruits belonging to the genera *Garcinia*, *Artocarpus*, *Phyllanthus*, *Annona*, *Averrhoa*, *Persia*, *Aegle*, *Passiflora* and *Tamarindus* etc., are found growing wild in the region. One of the indigenous fruits that require attention is jackfruit, which grows abundantly in Tripura, Assam, Nagaland and Meghalaya with a large number of cultivars and land races.

Of the 300 edible plant species found in the NE region, some of them are really worth consuming by various ethnic groups of the region. Two species of *Elaeagnus*, viz., *E. latifolia* and *E. pyriformis* are known to be grown in NE region [7]. It is quite common in Sibsagar (Dikho valley), Naga Hills, Khasi and Jaintia hills. *Docynia indica* and *D. hookeriana* are commonly found in the region. *Pyrus pashia*, a medium sized deciduous fruit tree is also found in NE region. Thejangulie et al. [8, 9] reported two types of tree tomato (Dark red cultivar and yellow cultivar. The dark red cultivar is rich in Total Soluble Solid (TSS) (11.43 %), acidity (1.66 %), ascorbic acid (253 mg/100 g) and anthocyanin (7.2 mg/100g), whereas the yellow colour cultivar is rich in moisture (83.57 %), lycopene (6.32 mg/100g) and carotene (0.65 mg/100g). The details of underutilized fruits which are commonly available in this region was documented by Patel et al. [10] and presented in Table 1.

Soh-Shang (*Elaeagnus latifolia*) is one of the important underutilized fruit crops widely distributed in Northeast India. Wide variability is observed in this fruit. The fruits are rich in bioactive compounds and fairly rich in essential fatty acids. Patel et al. [11] analyzed the different genotypes of Soh-Shang for their chemical properties (Table 2).

The physio-chemical properties of some underutilized fruits were analyzed by Patel et al. [12] in ICAR, Meghalaya and presented in Table 3. They reported that these underutilized fruits can be utilized for preparing value added products.

Vegetable crops

Vegetables comprising of solanaceous, cucurbitaceous, leguminous, leafy, cole, root, rhizomatous and bulbous crops constitute one of the biggest groups of cultivated plants. About 16,000 germplasm accessions of different vegetables, tuber, spices and condiments crops were collected through several crop specific and multicrop expeditions conducted by NBPGR alone or in collaboration with other institutes during the period 1986 to 1994-95 [13].

North Eastern region is the home for several solanaceous plants. It is estimated that at least 35 species belonging to family solanaceae occur in the region. Out of these, the inhabitants, particularly the tribal population consume 15-16 species as vegetable. Important but less known edible species among these are tree tomato (*Cyphomandra betacea* (cav.) Sendt.), *Solanum torvum* Sw., *Solanum indicum*, *Solanum macrocarpum* L., *Solanum xanthocarpum*, *Solanum stramineifolium* Jacq. and *S. gilo* Raddi and among them *S. gilo* is high prized vegetable of Khasi and Mizo tribes [14].

Chilli (*Capsicum* spp.) is usually grown in warm to hot and humid climate in Manipur, Mizoram, Meghalaya, Nagaland, Tripura and Arunachal Pradesh. The chilli species like *C. annum* L. var. *avicular*, *C. annum* L. var. *grossum*, *C. annum* L. var. *longum*, *C. chinense*, *C. eximium*, *C. frutescens*, *C. minimum*, and *C. pubescens* are available in this region. King chilli is the world's most pungent chilli (Guinness world record in September 2006) originated in Northeast India particularly in Nagaland and is cultivated throughout the region. Cucurbits, one of the largest groups of vegetable crops is widely cultivated in all the states of this region. Fifteen genera of this group of vegetables are found in this region and many of them are lesser known [8]. Kakrol (*Momordica cochinchinensis*) and Kartoli (*M.*

Table 1. Underutilized fruit crops of Northeast region

Scientific name	Common/ local name	Family	Distribution
<i>Actinidia strigosa</i>	Wild kiwi	Actinidaceae	Sikkim
<i>A. callosa</i>	Wild kiwi	Actinidaceae	Arunachal Pradesh
<i>Baccaurea sapida</i> (Roxb.) Muell.-Arg.	Leteku A.P., Tripura	Euphorbiaceae	Sikkim, Meghalaya, Assam,
<i>Averrhoa carambola</i> L	Carambola (Star fruit), Soh Pyrshong	Oxalidaceae	Meghalaya, Assam
<i>Docynia indica</i> <i>D. hookeriana</i> (<i>Eriolobus indica</i> Schn.)	Indian crab apple, Soh-pho (Khasi)	Rosaceae	Khasi hill (Meghalaya), Sikkim
<i>Emblica officinalis</i>	Aonla	Euphorbiaceae	All NE States
<i>Elaeagnus latifolia</i> Linn. <i>E. pyrifolia</i>	Soh-shang (Khasi)	Elaeagnaceae	North east frontier tracts, lower Assam Meghalaya
<i>Garcinia lanceaeifolia</i>	Thekera tenga (Assamese)	Clusiaceae	Meghalaya, Mizoram, Nagaland, Assam
<i>Myrica esculenta</i> M. nagi	Soh-phie (Khasi)	Myricaceae	All north eastern hill region
<i>Myrica fraquhariana</i>	Soh-phie (Khasi)	Myricaceae	Sibsagar (Dikho valley Assam), Naga hills, Khasi & Jaintia hill (Meghalaya)
<i>Passiflora edulis</i> P. <i>edulis</i> var. <i>flavicarpa</i>	Passion fruit (Soh-rub)	Passifloraceae	Meghalaya, Mizoram, Manipur, Nagaland, Sikkim
<i>Pyrus pashia</i>	Soh-shur (Khasi)	Rosaceae	Khasi & Jaintia hills (Meghalaya)
<i>Prunus nepalensis</i>	Soh-iong (Khasi)	Rosaceae	Khasi and Jaintia hills (Meghalaya)
<i>Dillenia indica</i>	Otenga (Assamese)	Dilleniaceae	Meghalaya, Assam
<i>Machilus edulis</i> King. Syn. <i>Percea</i> <i>fructifera</i> Kost	Pumsi (Sikkim)	Lauraceae	Sikkim, A.P. and other NE Region

Table 2. Chemical fruit properties of Soh-shang genotypes of Meghalaya

Genotypes	Fruit wt (g)	TSS (%)	Acidity (%)	pH	Ascorbic acid (mg/100 g pulp)	TSS: acidity ratio
RCE-1	15.17	8.9	3.74	3.1	4.8	2.38
RCE-2	22.94	9.0	4.03	3.1	4.8	2.23
RCE-3	15.29	8.8	3.23	3.2	9.6	2.72
RCE-4	6.73	11.2	1.96	3.7	9.4	5.71
RCE-5	13.51	9.2	3.37	3.2	7.2	2.73
RCE-6	10.74	10.0	3.07	3.3	7.2	3.26
Mean	14.06	9.52	3.23	3.27	7.17	3.17

dioica) are widely spread in Assam and the Garo hills of Meghalaya [15]. The details of cucurbits genotypes in Northeast India are given in the Table 5.

Wide variety of indigenous leafy vegetables like amaranth spp *Amaranthus viridis*, *A. lividus*, *A. retroflexus* and *A. spinosus*, puroi sag (*Basella rubra* and *B. alba*), sorrel (*Rumex rasicarius*), jilmilsag

(*Chenopodium album*) and Kalmou sag (*Ipomea reptans*) are grown in North East India [16]. Leafy vegetables like *Houttuynia cordata* Thunb, *Fagopyrum cymosum*, *Justica*, *Rauvolfia*, *Rheum*, *Piper*, *Centella asiatica*, *Plantago major*, *Alisma*, *Monochoria*, *Adhatoda viscia*, *Eeringium foetidum*, *Leucas aspera*, *Homalomena*, *Begonia*, *Abelmoschus*, *Mentha*

Table 3. Physico-chemical parameters of a few indigenous fruits of NE Region

Fruit	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Pulp weight (g)	Juice content	TSS (%)	Acidity (%)
Tader	6.00	3.93	47.55	-	-	-	5.4
Belam	3.24	2.70	13.87	10.83	-	8.0	-
Empe	2.59	2.53-2.0	7.66	-	-	-	-
Hisir	3.27	2.11	8.73	5.61	-	-	-
Tayek Ekse	2.40	2.43	10.04	5.13	-	-	-
Elaichi Nimbu (Smooth skin)	8.38	6.95	204.76	120.29	27.27	6.5	5.21
Elaichi Nimbu (Rough skin)	8.95	7.60	252.50	151.00	35.00	6.0	4.86
Tanyum	9.03	6.63	173.31	92.444	16.90	6.7	5.60
Rabab Tenga	11.05	11.40	575.00	474.55	151.50	10.2	1.73
Kodok Dogli	8.4	2.87	36.91	17.54	-	15.5	-
Kodok Dogyo	9.05	3.02	36.7	18.125	-	9.6	-
Kolu	11.0	2.09	30.37	16.03	-	-	-

Table 4. Diversity of Solanaceous species in Northeast (NE) region of India

Cultivates species	Specific features
<i>Solanum macrocarpon</i> L.	Introduced in NE region
<i>Solanum xanthocarpum</i> Schard & Wendl	Used as vegetable and medicinal purpose
<i>Solanum indicum</i> L.	Domesticated, used as vegetable and medicine
<i>Solanum mammosum</i> L.	Possibly introduced, ornamental with high solasodine percentage
<i>Solanum khasianum</i> Clarke	Wild and cultivated for solasodine alkaloid
<i>Solanum torvum</i> Swartz.	Wild, sold in the market in Mizoram
<i>Solanum berbisetum</i> Nees	Ripe fruits are eaten
<i>Solanum ferox</i> L.	Wild, leaves are used medicinally
<i>Solanum spirale</i> Roxb.	Wild but domesticated for medicinal use in Arunachal Pradesh
<i>Solanum sisymbriifolium</i> Lam.	Native of Africa, wildy grown in Meghalaya
<i>Solanum kurzii</i> Br.	Endemic in Garo hills, Meghalaya
<i>Solanum gilo</i> Raddi.	Introduced in NE region as vegetable

arvensis, *Spilanthes acemella*, Brassica, *Bacopa monnieri*, *Amaranthus viridis*, *Comelina bangalensis*, *Colocasia esculenta*, *Oxalis corniculata*, Rumex, *Chenopodium album* and different species of bring numbered species in order 1-11 etc. are commonly available in kitchen garden and forest of the region more particularly in Meghalaya. The nutritional properties of some of the leafy vegetables were also analyzed [17] and the data are presented in Table 6.

High genetic diversity for tuber and rhizomatous crops viz., *Ipomea batatas*, *Colocasia esculenta*,

Amorphophalous bulbifera, *Amorphophallus paeoniifolius*, *Amorphophallus campanulatus*, *Dioscorea alata*, *D. bulbifera*, *D. oenitophylla*, *D. esculenta*, *D. pubera*, *D. arachnida*, *D. belophylla*, *D. trinervia*, *D. wattii*, *D. sativa*, *D. kamoonsensis*, *D. pentaphylla*, *D. cylendrica*, *D. hamiltonii*, *D. oppositifolia* and *D. prazeri* are found in Northeastern region [16, 18, 19]. Ginger and turmeric are very popular and commercially cultivated in Northeast.

Table 5. Diversity of cucurbits in Northeast India

Cultivates species	Area of concentration	Range of diversities
<i>Cucurbita maxima</i>	Throughout the country	Extensive
<i>Cucurbita moschata</i>	Hilly areas	Moderate
<i>Cucurbita ficifolia</i>	Meghalaya	Introduced, neutralized
<i>Cucurbita pepo</i>	Meghalaya, Mizoram	Limited
<i>Coccinia grandis</i>	Assam, West Bengal	Limited
<i>Cucumis sativus</i>	Throughout the country	Wide
<i>Cucumis callosus</i>	Foothill areas of Assam	Confined to limited pockets
<i>Luffa acutangula.</i>	Tropical areas of Assam	Wide
<i>Luffa cylindrica</i>	Tropical and subtropical areas of Assam, Meghalaya, Manipur, West Bengal	Moderate
<i>Momordica charantia.</i>	Throughout the country	Moderate
<i>Momordica cochinchinensis</i>	Assam, Meghalaya, Manipur, West Bengal	Limited
<i>Momordica dioca</i>	Garo Hills	Rare
<i>Trichosanthus anguina</i>	Meghalaya, Tripura, Assam, West Bengal	Limited
<i>Trichosanthus dioca.</i>	Tropical areas of Assam, Tripura	Limited
<i>Cylanthra pedata</i>	Hills of Meghalaya, Manipur, Nagaland and Arunachal Pradesh	Moderate
<i>Benincasa hispida</i>	Assam, Nagaland, Meghalaya	Wide
<i>Lagenaria siceraria</i>	Throughout the country	Wide
<i>Sechium edule</i>	High hills of Meghalaya, Manipur, Mizoram, Nagaland, Sikkim and Darjeeling of West Bengal	Moderate

Flower crops

The commercial crops like rose, anthurium, liliun, and gerbera are introduced and commercially cultivated in open and protected cultivation. Orchids are very popular and Northeast is known for its rich diversity. Of 17,000 species of orchids in the world, about 1,250 occur in India and about 700 occur in the north eastern region, of which around 324 occur in Meghalaya alone [20]. The native species of orchids having ornamental value and market potential usually belong to *Aerides*, *Anachnantha*, *Arundina*, *Cymbidium*, *Dendrobium*, *Paphiopedillum*, *Phaius*, *Renanthera*, *Phycostyllus* and *Vanda* etc. [21]. Fourty orchid species belonging to 16 genera were evaluated for their potential for cut flowers. Among the species evaluated *Calanthe masuca*, *Cymbidium giganteum*, *Dendrobium nobile*, *Phaius tankervilleae*, *Renanthera imschootiana*, *Thunia marshalliana*, *Vandacoerulea* were found promising as cut flowers [22].

Bamboo

Bamboo is one of the important crops of Northeast and

it plays a very crucial role in livelihood of the tribal people. Around 50 per cent of bamboo species in India are available in Northeast, among them, 12 species are rare and endangered [23]. Arunachal Pradesh itself has 12 genera and 30 species [24]. The important bamboo species available in Northeast India are *Bambusa balcoa*, *B. pallida*, *B. nutans*, *B. tulda*, *B. cacharensis*, *B. arundinacea*, *Dendrocalamus giganteus*, *D. hookerii*, *D. sikkimensis*, *D. hamiltonii*, *D. sahnii*, *D. asper*, *Cephalostacyum pergracile*, *B. variegata*, *B. vittata*, *Zoram local*, *B. balcoa*, *B. khasiana*, *B. nana*, *Hard jati*, *B. cacherensis*, *B. japonica*, *Arundinaria hirsute*, *A. manii*, *Phyllostachys pubescens*, *P. polymorphum*, *B. multiplex*, *Teinostachym helferii*, *B. Polymorpha*, *C. armata*, *Chimonobambusa grafithiana*, *B. wamin*, *Khupri*, *Ochlandra ebracteata*, *Arundinaria gracilis*, *A. maling*, *A. racemosa*, *B. longispiculata*, *B. vulgaris*, *Chimonobambusa callosa*, *D. patellaris* and *Gigantochloa albociliata*.

Medicinal plants

The tribal communities in Northeast India are well aware of the wild plants having medicinal values. The tribal

Table 6. Nutritive value of leafy vegetables of NE region of India

Vegetables	Protein (g)	Minerals (g)	Crude fibre (g)	Calcium (mg)	Phos-phorus (mg)	Iron (mg)
Amaranthus caudatus	3	3.3	1.0	200	40	-
Amaranthus gangeticus	4.0	2.7	1.0	397	83	3.49
Amaranthus paniculatus	5.9	3.8	2.1	530	60	18.4
Amaranthus spinosus	3.0	3.6	1.1	800	50	22.9
Chenopodium album (jilmil)	3.7	2.6	1.8	150	80	4.2
Bottle gourd leaves	2.3	1.7	1.3	80	59	-
Colocasia leaves (black)	6.8	2.5	1.8	460	125	0.98
Colocasi leaves (green)	3.9	2.2	2.9	227	82	10.0
Curry leaves	6.1	4.0	6.4	830	57	0.93
Drumstick leaves	6.7	2.3	0.9	440	70	0.85
Fenugreek leaves	4.4	1.5	1.1	395	51	1.93
Garden sorrel (Chuka sak)	0.6	0.9	1.3	130	20	1.7
Ipomoea leaves (kolmow)	2.9	2.1	1.2	110	46	3.9
Mustard leaves	4.0	1.6	0.8	155	26	16.3
Radish leaves	3.8	1.6	1.0	265	59	0.09
Dhekia (ferns)	-	13.15	7.8	-	-	-

Table 7. Medicinal crops of Northeast region

Name of the species	Common uses against disease
<i>Panax psuedoxinseng</i>	AIDS
<i>Hydnocarpus curzii</i>	Leprosy
<i>Litsea cubeba</i>	Paralysis
<i>Clerodendrum colebrookianum</i>	Heart disease
<i>Coptis teeta</i>	Malaria
<i>Vitex trifolia</i>	Tuberculosis
<i>Aconitum heterophyllum</i>	Diabetes and rheumatism
<i>Alpinia galanga</i>	Skin disease
<i>Curcuma caesia</i>	Swellings, sprains
<i>Taxus baccata</i>	Breast cancer
<i>Acorus calamus</i>	Influenza, headache, cough, cold
<i>Ambrosia artimisiifolia</i>	wounds, cuts
<i>Antidesma brunius</i>	syphilic ulcers
<i>Achyranthes aspera</i>	leprosy

people are using these plants for treating various ailments. It was reported that 200 species from Arunachal Pradesh, 256 from Assam, 526 from

Nagaland, 194 from Tripura [25, 26] and 834 species from Meghalaya have medicinal value and these plants have been used by the tribal community of this region for the time immemorial. The important plant species having medicinal value are listed below in the Table 7.

Value addition and post harvest management of horticultural crops

Indigenous and minor horticultural crops available in the region are not being exploited properly, but they have the potential to alleviate the poverty, food and nutritional security through processing, value addition and diverse use. These fruits and vegetables are rich in vitamins and minerals. Besides, they are rich in secondary metabolites and medicinal properties which could be exploited in industrial and medicinal sectors. Moreover, these underutilized crops are having the capability of growing in adverse environmental conditions. The farmers of Northeast have the awareness about these crops and their medicinal values. Moreover, many of the farmers use these properties to cure some diseases. However, these crops are not grown commercially and confined either in backyard garden or in the forest.

Table 8. Details of the crops utilized for different commercial products

Products	Name of the species
Pickle	<i>Artocarpus heterophyllus</i> , <i>Atlantia monophylla</i> , <i>Ehretia accuminata</i> , <i>Eleagnus umbellate</i> , <i>Elaeocarpus floribundus</i> , <i>Mangifera sylvatica</i> , <i>Averrhoa carambola</i> , <i>Emblica officinalis</i> , <i>Citrus medica</i>
Jam	<i>Emblica officinalis</i> , <i>Averrhoa carambola</i> , <i>Prunus nepalensis</i> , <i>Roselle</i>
Jelly	<i>Ficus auriculata</i> , <i>F. hispida</i> , <i>F. semicordata</i> , <i>Flacourtia jangomas</i> , <i>Garcinia lancaefolia</i>
Preserve	<i>Citrus medica</i> , <i>Cornus capitata</i> , <i>Corlaria nepaulensis</i> , <i>Docynia hookeriana</i>
Beverages	<i>Aegle marmelos</i> , <i>Dillenia indica</i> , <i>Diospyros lotus</i> , <i>Grewia sapida</i> , <i>Feronia limmonia</i> , <i>Myrica esculenta</i> , <i>Garcinia lancaefolia</i> , <i>Prunus nepalensis</i>
Fibre	<i>Artocarpus chaplasi</i> , <i>A. lakoocha</i> , <i>Grewia sapida</i> , <i>Ananas sativus</i> , <i>Musa paradisiaca</i>
Essential oil	<i>Gaultheria fragrantissima</i> , <i>Juglans regia</i> , <i>Litsea cubeba</i> , <i>Madhuca longifolia</i> , <i>Messua ferrea</i> , <i>Assam lemon</i> , <i>Kachai lemon</i> , <i>alpinia</i> , <i>cinnamomum</i> , <i>cymbopogon</i> , <i>ocimum</i> , <i>pogostemon</i>
Dye	<i>Aporusca dioica</i> , <i>Baccaurea sapida</i> , <i>Garcinia lanceafolia</i> , <i>Myrica nagi</i> , <i>curcuma</i>

Table 9. Sensory quality of Jam with variable juice content

Juice/ pulp %	Sensory score	
	Passion fruit Jam	Sohiong Jam
50	6.7	5.4
60	6.7	6.3
70	7.4	7.4
80	8.1	7.7
90	5.5	8.2
100	5.0	7.4

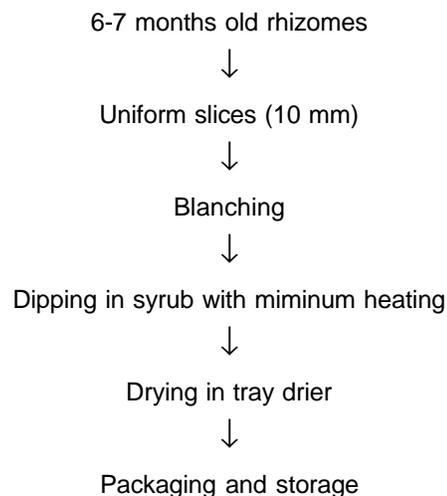
Potential underutilized horticultural crops for value addition

Underutilized horticultural crops can be exploited for processing as most of them are rich in nutritive and medicinal values, but are highly perishable in nature. The protocols for preparation of instant ginger candy, minimally processed ready to cook jack fruit, jam from *Prunus nepalensis*, roselle, RTS beverages from *Dillenia indica*, *Myrica esculenta*, *Assam lemon*, *Prunus nepalensis* and tuiy fruity from chow-chow have been standardized. Different species used for preparation of products like pickle, jam etc. are give in Table 8.

Preservation of green ginger and ginger candy

Northeast India is famous for ginger cultivation. However, the tribal farmers are facing problem in the marketing of fresh ginger rhizomes. The green ginger

can be preserved up to 8-10 months without affecting its quality in the 9 per cent brine solution containing 2 per cent citric acid [27]. Nath *et al.* [28] standardized the procedure for making instant ginger candy (Fig. 1).

**Fig. 1.** Steps involved in making ginger candy

Minimally processed ready-to-cook jack fruit

Artocarpus sp is widely found throughout the Northeast. The tribal people use jack leaves as fodder for their cattles. The ripe fruits are nutritious and rich in vitamins and minerals. The tribal community uses immature fruit as vegetable. ICAR Research Complex for NEH Region [29] standardized the protocol (Fig. 2) for minimally processed ready-to-cook jack fruit. The product can be stored for a period of 6-8 months.

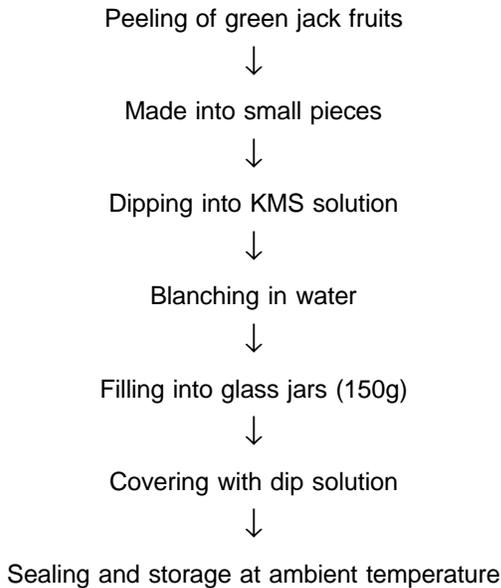


Fig. 2. Steps involved in processing of ready-to-cook jack fruit

Chow-chow Tuity fruity

Chow-chow (*Sechium edule*) is very popular in Northeast particularly in Mizoram and Meghalaya. In peak season, there is glut in the market and the farmers receives poor price. ICAR Research Complex for NEH Region has standardized the protocol (Fig. 3) for making tuity-fruity from chow-chow which could be highly remunerative to the farmers [30].



Fig. 3. Steps of fruity-fruity preparation from chow-chow

Jam from passion fruit and *Prunus nepalensis*

Passion fruit (*Passiflora edulis*) and Sohiong (*Prunus nepalensis*) are the important underutilized fruit crops

in Northeast India. However, the fruits are sour in taste. ICAR Research Complex for NEH Region [31] has standardized the protocol for making jam from these fruits. Good quality jam could be prepared with 80 and 90% juice of passion fruit and sohiong, respectively (Table 9).

Bamboo shoots pickle

Northeast India is rich in bamboo genotypes suitable for pickle preparation. Bhagwati and Deka [32] screened different bamboo species to identify the suitability for pickle preparation. Among the species evaluated *Bamboosa balcooa* was identified as the best species for preparation of pickle (Table 10).

Mirika tenga (*Parameria polyneura*)

Mirika tenga (*Parameria polyneura*) is a very popular and important minor fruit indigenous to Northeast India and is consumed as fresh fruit when it is ripened. The fruit is very sour in taste and rich in vitamin C [33]. The authors revealed that the fruit can be suitably utilized for preparation of value added products like jelly, chutney, pickle etc. (Table 11).

Strategies for improvement of indigenous/ commercial horticultural crops of North East India

To tap the vast underutilized or less utilized horticultural crops for nutritional security and income generation, the following steps will go a long way in commercialization of these crops. Steps for development of appropriate technology for their improvement must be initiated immediately so as to harness the potentiality of these crops.

Pineapple

- (i) Development of varieties having cylindrical shaped fruits for processing industries
- (ii) Technologies for increasing the sweetness of fruits harvested during winter season

Khasi mandarin

- (i) Organic crop improvement technologies to minimize the pre and post harvest diseases
- (ii) Mass propagation technology as a substitute to budding/ grafting

Passion fruit

- (i) Development of disease resistant varieties (Stem swelling) for better juice yield
- (ii) Mass propagation technologies and its popularization

Table 10. Biochemical properties of pickle prepared from bamboo shoots

Class of bamboo	Name of the species	TSS (%)	Crude fiber(%)	Total alkaloid (%)	Ascorbic acid (mg/100 g)	Overall sensory score
Bhaluka	<i>Bambusa balcooa</i>	7.74	7.50	0.19	1.410	8.00
Jati	<i>Bambusa tulda</i>	6.74	7.50	0.25	1.060	6.43
Mokal	<i>Bambusa nutans</i>	5.74	8.00	0.26	0.920	5.83
Kako	<i>Dendrocalamix homiltonii</i>	4.74	7.50	0.21	0.894	6.79
Kako (Var)	<i>Dendrocalamix homiltonii var. giganteus</i>	5.74	7.50	0.21	0.893	6.79
Dolo	<i>Temostochym dulooa</i>	5.74	7.50	0.22	0.890	5.17
Bijuli	<i>Bambusa pallid</i>	5.74	12.00	0.23	0.756	5.00
Bajal	<i>Bambusa polymorpha</i>	4.74	12.00	0.23	0.916	6.17
Muli	<i>Melooanno bambusoides</i>	5.74	12.00	0.23	0.789	5.43
Exotic	<i>Bambusa bamboos</i>	6.7	10.00	0.22	1.060	5.27
CD= 0.05		1.616	3.007	NS	0.244	1.540

Table 11. Parameters of the value added products of Mirika tenga

Parameters	Jam	Jelly	Chutney	Squash	Pickle	S.Ed ±	CD _{0.05}
Colour	7.50	8.60	8.40	7.40	8.53	0.24	0.54
Flavour	7.00	8.00	7.80	7.60	8.33	0.37	0.83
Taste	7.40	7.80	7.90	7.60	8.13	0.24	NS
Consistency	7.00	8.13	8.14	7.86	8.40	0.13	0.28
Overall acceptability	7.00	8.33	8.00	7.86	8.26	0.19	0.42

(ii) Pruning and training technology

Other Minor fruits

- (i) Development/ identification of suitable cultivars for processing and value addition
- (ii) Mass propagation technology for quality planting materials
- (iii) Pruning and training technology

Chow chow

- (i) Identification/ development of suitable cultivars for processing and value addition
- (ii) Standardization of maturity indices for better processing quality

Tree tomato

- (i) Identification/ development of suitable cultivars having higher TSS and Vitamin C
- (ii) Mass propagation technology for better quality planting materials

Colocasia and other tuber crops

- (i) Identification/ development of acidity free or low varieties for both leave and tuber purpose
- (ii) Standardization of maturity indices for better processing quality

Leafy vegetables

- (i) Identification/ development of HYV for better quality
- (ii) Sound seed/planting material production programme
- (ii) Technology standardization for minimal processing and packaging

Ginger

- (i) Development/ identification of varieties having higher rhizome and oil yield
- (ii) Sound organic technology for export market
- (iii) Standardization of maturity indices for better oil content and other processed products

Turmeric

- (i) Development/ identification of varieties having higher rhizome yield, dry matter and curcumin content
- (ii) Sound organic technology for export market
- (iii) Standardization of maturity indices for better curcumin content and other processed products

Chillies

- (i) Identification/ development of multiple disease resistant varieties having higher capsaicin and oil content
- (ii) Low cost drying technology for North eastern region

Bamboo

- (i) Identification/ Development of varieties exclusively for value added product
- (ii) Standardization of maturity indices for different value added products

There is great potential for underutilized horticultural crops in Northeast India. These underutilized crops are rich in vitamins and minerals and many of the crops have medicinal properties too. They can be effectively exploited to supply balanced diet to the tribal communities of this region. Priority should be given to exploration, characterization, conservation, and protection of these germplasm. The strategies for standardization of technologies and crop improvement for these crops should be initiated with prime importance to exploit them for value addition, processing and secondary metabolite production.

References

1. **Mao A. A. and Hynniewta T. M.** 2000. Floristic diversity of Northeast India. *J Assam Sci. Soc.*, **41**: 255-266.
2. **Asati B. S. and Yadav D. S.** 2004. Diversity of horticultural crops in Northeastern region. *ENVIS Bulletin: Himalayan Ecology*, **12**: 1-11.
3. **Tanaka T.** 1928. On certain new species of Citrus, *Stud. Citrol.*, **2**: 155-164.
4. **Tanaka T.** 1937. Further revision of Rutaceae-Aurantioideae of India and Ceylon (Revisio aurantiacearum VIII), *J. Ind. Bot. Soc.*, **16**: 227-240.
5. **Mabberley D. J.** 2004. *Citrus* (Rutaceae): a review of recent advances in etymology, systematics and medical applications. *Blumea*, **49**: 481-498.
6. **Malik S. K. Chaudhury R., Dhariwal O. P. and Kalia R. K.** 2006. Collection and characterization of *Citrus indica* Tanaka and *C. macroptera* Montr.: wild endangered species of northeastern India. *Genet. Res. Crop Evol.*, **53**: 1485-1493.
7. **Pandey G.** 2002. Popularizing under exploited fruits for consumptions, *Indian Horticulture*, Oct.-Dec., pp. 18-21.
8. **Yadev R. K., Deka B. C. and Sanwal S. K.** 2009. Genetic resources of vegetables crops of North Eastern Himalayan Region. *ENVIS Bulletin: Himalayan Ecology*, **17**.
9. **Thejangulie Angami, Kabita Choudhury, Sanju Singh M., Verma V. K. and Deka B. C.** 2011. Chemical characteristics of tree tomato - A substitute for tomato. *Plant Hort. Tech. Bulletin*, June-July, p. 42-45.
10. **Patel R. K., Singh A. and Deka B. C.** 2008a. Soh-Shang (*Elaeagnus Latifolia*): An under-utilized fruit of North East region needs domestication. *ENVIS Bulletin: Himalayan Ecology*, **16**: 8-13.
11. **Patel R. K., Singh A., Deka B. C. and Ngachan S. V.** 2008b. Hand book of fruit production, published by ICAR Res. Complex for NEH Region, Barapani, pp. 88-90.
12. **Patel R. K., De L. C., Akath Singh and Deka B. C.** 2010. Lesser Known Edible Fruits of North Eastern India. *In: Underutilized and underexploited Horticultural crops*, **5**: 163-173.
13. **Gupta P. N., Rai M. Chandra, U. Kochhar, S. Singh B. and Kamala V.** 1995. Management of vegetable crops germplasm-current status, *Indian J. Pl. Genetic Resour.*, **82**: 173-181.
14. **Sharama B. D., Paul Swamy S. and Hore D. K.** 1994. *Solanum gilo* Raddi – a lesser known vegetables of North eastern India, *Indian J. Pl. Genet. Resour.*, **7**: 109-111.
15. **Ram D., Kalloo G. and Banerjee M. K.** 2002. Popularizing kakrol and kartoli: the indigenous nutritious vegetables. *Indian Hort.*, 6-9.
16. **Sarma B. K.** 2001. Underutilized crops for hills and mountain ecosystems. Summer school on agriculture for hills and mountain ecosystem, ICAR. pp. 308-314.
17. **Saikia A.** 1989. Evaluation of indigenous leafy vegetables of Assam for nutritive characters. M.Sc. Thesis. Submitted to Assam Agricultural University, Jorhat, Assam.
18. **Nathani H. B.** 1990. Flowering plant of India, Nepal and Bhutan Dioscoreaceae, (Ed. HB Nathan). pp. 439.
19. **Rao A. S. and Verma D. M.** 1973. Materials towards a monocot flora of Assam-III (Taccaceae, Dioscoreaceae and Stemonaceae). *Bull. Bot. Surv. India*, **15**: 191-203.

20. **Sharma J. and Kumar Y.** 1993. Orchid of North eastern India: an emphasis on Orchid industry for trade, Indian J. Hill Farming, **6**: 213-215.
21. **Borthakur Dharendra Nath.** 1992. Agriculture of the North Eastern region with special reference to hill Agriculture. Beecee Prakashan, Guwahati, pp 47-58.
22. **Rajiv K., Deka B. C. and Roy A. R.** 2012. Evaluation of orchid species under mid sub-tropical hills of Meghalaya. Hort. Flora Res. Spectrum, **1**: 24-28.
23. **Biswas S.** 1988. Studies on bamboo distribution in North-eastern region of India. Indian Forester, **114**: 514-531.
24. **Beniwal B. S. and Haridasan K.** 1988. Study of bamboos through establishment of bambusetum in Arunachal Pradesh. Indian Forester, **114**: 650-655.
25. **Hynniewta T. M.** 1984. Ethnobotanical investigation of some tribes in Arunachal Pradesh. Proc. Second Annual Workshop on MAB Project. pp. 83.
26. **Hynniewta T. M.** 1987. Annual report. All India Coordinated Research Projection Ethnobiology, Ministry of Environment and Forests, Govt. of India.
27. **Soma Pun.** 2006. Studies on value addition in ginger. MSc. Thesis, Submitted to Assam Agricultural Univeristy, Jorhat, Assam.
28. **Nath A., Deka B. C., Jha A. K., Paul D. and Mishra L. K.** 2012. Effect of slice thickness and blanching time on different quality attributes of instant ginger candy. J. Food Sci. Technol., (DOI: 10. 1007/s 13197-01-0619-x).
29. **Anonymous.** 2010. Annual Report. ICAR Research Complex for NEH Region, Umiam, Meghalaya, 2010-11.
30. **Nath A., Deka B. C. and Ngachan S. V.** 2010. Tuity-Fruity from chow-chow. Filed Patent: No. 1114/ Kol/ 2010 dtd. 05.10.10.
31. **Anonymous.** 2009. Annual Report. ICAR Research Complex for NEH Region, Umiam, Meghalaya, 2009-10.
32. **Bhagwati S. and Deka B. C.** 2004. Screening of bamboo species for pickle preparation. Indian Food Packer. March-April, p. 49-53.
33. **Neog N. and Deka B. C.** 2006. Product development from *Mirika tenga Parameria polyneura*. Indian Food Packer, September-October. p. 40-45.