REVIEW ARTICLE

Underutilized Fruits of Assam for Livelihood and Nutritional Security

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Abstract

India is endowed with a rich genetic diversity of fruits. The Hindustani center represents 344 species of fruits. Northeast India, meeting ground of Indo-Malayan and Indo-Chinese bio-geographical areas is one of the 18 mega-biodiversity centers of the World, has contributed the fruit genera like *Citrus, Musa, Mangifera, Docynia, Elaeocarpus, Myrica, Morus, Artocarpus,* etc. There are a quite large number of indigenous and underutilized fruit crops, which are being used by the local inhabitants in rural areas. These underutilized fruits are fairly rich in vitamins, minerals, antioxidant properties and are serving as protective food. Because of their curative properties, different parts of these fruits and plants have been used in ethnomedicine. Apart from their nutritive and medicinal values, quite a few of these underutilized fruits have good flavor, color and juice content and can be used for value additions. Several underutilized fruit species which have the potential for commercial exploitation are yet to be utilized to their potential. These fruit crops have not undergone any conscious phase of domestication and selection. Their cultivation is very restricted, and they grow in wild and semi-wild condition and adapt to local climatic conditions. Hence they can thrive even under the most adverse situation. Their adoption on a commercial scale, with crop improvement, standardization of cultural practices and popularization in diverse farming systems and value additions are warranted to achieve stability in farm production and food security. Many underutilized species, well adapted to marginal lands and with low-cost inputs, may thus be of great benefit for the survival of poor communities, employment generation and sustainability of agricultural ecosystems.

Keywords: Fruits, Minerals, Nutrition, Underutilized, Vitamins

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Introduction

Many of the tropical indigenous and temperate fruits have still remained underexploited due to the lack of awareness of their potential, market demand and low and erratic bearing in many cases. Though wild and domesticated diversity is composed of nearly 3000 tropical fruit species, only a few are cultivated on a large scale (Pareek *et al*., 1998). These species (approximately 600 tropical and subtropical) are better known in their areas of diversity and have not yet been utilized to their full potential. There exists a very rich diversity of fruits across the tropical and sub-tropical regions of the world, with more than 500 species of fruits estimated to be found in southeast asia alone. South and southeast asia represent above 300 species of native minor fruits (Arora, 1995). This area has been the center of origin of a number of tropical and temperate fruit species, most of which are still growing in wild or semi-wild state. Despite the wide diversity of these fruits, only some important fruits like mango, banana, citrus and guava have gained popularity. These species are being used by local people as minor fruits as well as for medicinal purposes as described in the Indian system of medicine. If properly harnessed this diversity has great potential as a source of food besides meeting the multipurpose needs of the local communities (Pareek *et al*., 1998).

In the strategic framework for research and development of underutilised plant species recently developed by International Centre for Underutilized Crops (ICUC), Colombo and a range of stakeholders, underutilized plant species are defined as 'species with underexploited potential for contribution to food security, health (nutritional and/or medicinal), income generation and environmental services'. In addition to 'underutilized', a wide range of other terms are used to describe these species, including 'minor', 'neglected', 'local', 'traditional', 'underexploited', 'underdeveloped', 'orphan', 'lost', 'new', 'niche', 'promising' and 'alternative'. Each term suggests a certain perspective with regard to limited use, but the meaning of terms is not always clear. For example,

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'new' species are new in relation to what? Are species new in terms of an introduction to a new geographical area or ecosystem, or new in the sense that the plant has not previously been harvested (anywhere) as a crop? Some terms, such as 'neglected' or 'orphan', carry negative connotations. It is difficult to give a concise description of underutilized plant species characteristics, and this is reflected in the wide range of labels applied to this group of taxa. Many use the 'underutilized plant species' label, and related terms, to describe plants that have a range of properties, some of which can be seen positively and others that have negative implications, in relation to patterns of use (Dawson and Jaenicke, 2006).

The positive features of these species often play a crucial 'safety net' role in poor communities for food security, nutrition, health and income generation, and provide additional important cultural and environmental services. Species are often well-accepted through long traditional use, which has led to the development of stable informal germplasm supply pathways for their distribution and regeneration. Long familiarity means that poor farmers hold extensive germplasm and knowledge on these species; this can empower communities and encourages self-reliance, with these taxa perhaps one of the few assets they have under their direct control. Many species have excellent nutritional profiles, with high protein, vitamin and mineral contents that can contribute to alleviating malnutrition ('hidden hunger.' Often, species appear highly diverse morphologically, with a wide genetic resource base assumed to be available for harnessing in potential improvement programs (this wide gene pool also provides opportunities for the improvement of related major crops). In addition, some species can grow well with low inputs in marginal lands that are often difficult to place under alternative production systems; this is an important consideration as the area occupied by marginal lands increases due to environmental degradation (through drought, soil loss, increased salinity and other factors).

The negative features within these species tend to be important (cultivation, sale and use) locally or regionally only (or only in restricted niches if distributed more widely). This geographic restriction is partly due to limited dissemination of knowledge and germplasm, but may also, among other factors, reflect biological limitations in crossing ecological boundaries. Furthermore, various species are limited by one or other of a number of other inherent biological characteristics, including difficulties in harvesting, low yield, low storage capability, susceptibility to various diseases (especially when grown more widely) and difficulties in propagation, sometimes compounded by reproductive factors such as dioecy (separate male and female plants). Propagation problems not only make distribution difficult but also restrict manipulation in breeding programs. Furthermore, because these species often have multiple uses, crop improvement techniques that focus on only one character can be inappropriate (Dawson and Jaenicke, 2006). So, minor fruits are the fruits not so extensively cultivated and with consumption and trade being more limited both geographically and quantitatively, although many are of considerable importance in their respective regional markets. Some minor fruits are major fruits in their regions of influence (Sauco, 2008). These underutilized fruits can make a specific contribution to human nutrition, constituting as they do an important part of local diets throughout the tropics. Many underutilized species are well adapted to marginal lands and with low-cost inputs, may thus be of great benefit for the survival of poor communities and sustainability of agricultural ecosystems. While it is true that these underutilized fruits are generally low yielding, it is also true that for one reason or another, these species have been ignored by virtually all stakeholders involved in the field, from researchers and extensionists to farmers, policy and decision-makers, donors, technology providers, and finally consumers. In consequence, not enough is known about their agronomy, cultivar selection, yield improvement, postharvest practices, potential markets, and commercialization processes.

Underutilized fruits include species with potential for commercial development, species with potential for home garden use, with potential use for nutraceutical purposes (medicine and cosmetics) or as source of substance for pest control or natural growth regulators, as timber, fuel, oils, gums, and waxes for the industry, as livestock feed and their intrinsic value as genetic resources.

Diversity of underutilized fruits

Northeast India comprises eight states viz., Arunachal Pradesh, Assam, Meghalaya, Manipur, Tripura, Mizoram, Nagaland and Sikkim. The total area of northeast occupies 7.7 % of India's total geographic areas supporting 50% of the biodiversity in the country (Mao and Hynniewta, 2000), of which 31.58% is endemic. It is one of the hot spots in India (Asati and Yadav, 2004), known for its diverse nature of soil, climate and topography. The region has reach source of diversity of *Averrhoa carambola, Artocarpus lakoocha, Baccaurea sapida, Carassia carandas, Chrysophyllum roxburghii, Castanopsis indica, Calamus erectus, Carallia lucida, Dillenia indica, Docynia hookeriana, Eugania cymosa, Elaegnus pyriformis, Elaegnus latifolia, Emblica officinalis, Flacourtia jangomas, Gynocardia odorata, Mangifera sylvatica, Myrica fraquhariana, Myrica nagi, Pyrus pashia, Prunus nepaulensis, Prunus jenkinsii, Passiflora edulis, Paramaria polyneura, Phyllanthus acidus, Physalis peruviana, Rubus ellipticus, Rhus semialata, Spondias mangifera, Syzygium jambose,* etc.

In northeast India, species of *Garcinia* grow extensively in a semi-wild state, in the evergreen forests of Assam, Khasi, Jantia hills. The sundried slices of the fruits are used for culinary purposes and as folk medicine. Species, like *Garcinia pedunculata*, *G. kydia*, *G. cowa* and *G. lancifolia* are the most important species in North Eastern parts of India (Table 1).

Table 1: Garcinia species available in northeastern States

Species	*Distribution*
Garcinia anomala Planc.	Khasi hills
Garcinia atroviridis Griff	N.E. districts of Assam
Garcinia cowa Roxb. (*Garcinia kydia* Roxb.)	Eastern India including Assam
Garcinia lanceaefolia Roxb.	Assam, Khasi hills
Garcinia morella Desr.	Assam, Khasi hills
Garcinia paniculata Roxb.	Assam, Khasi hills
Garcinia pedunculata Roxb.	Assam, Manipur
Garcinia xanthochymus Hook. (*Garcinia tinctoria* Wight *Garcinia pictorius* Roxb.)	Assam, Meghalaya

Source: Parthasarathy *et. al.* (2013)

Underutilized fruits for nutritional security

Underutilized Fruits and nuts are important source of vitamins such as ascorbic acid (C), carotenoids (A), thiamine (B_1), riboflavin (B_2), niacin (B_3), pyridoxine (B_6), and folacin, minerals, fat, protein, and dietary fiber (Quebedeaux and Bliss, 1988; Quebedeaux and Eisa, 1990; Craig and Beck, 1999; Wargovich, 2000). Nuts are a good source of essential fatty acids, fiber, vitamin E, and minerals. Other important nutrients supplied by fruits include, zinc, calcium, potassium, and phosphorus (Kader *et al*., 2005). Most of the food resource is available in plenty during a particular season, but all have not been utilized to the desired extent due to many reasons. Thus, people residing in rural areas hardly get considerable advantage from the abundantly available resources. The solution of the problem lies only in evolving the techniques of value addition, providing market, and educating the villagers about the nutritional quality of underutilized fruits. Processing and value addition of tribal fruits into more useful, digestive, tasteful, and convenient products ultimately improves the economic value of underutilized fruits and develop nutritional security of the village dwellers.

Sources of HCA

Garcinia is the source for a natural diet ingredient (-) hydroxycitric acid. HCA, (1,2-dihydroxypropane-1,2,3-tricarboxylic acid), which is an anti-obesity compound present in the fruit rind and leaves of *Garcinia* and is known to inhibit lipid and fatty acid synthesis in living systems (Lewis and Neelakandan, 1965). HCA is also a hypocholesterolamic agent (Lowenstein, 1971). On a dry weight basis, HCA constitutes about 20-30% of the fruit (Table 2).

Table 2: HCA content of some *Garcinia* species

	HCA content (%)		
Species	*Leaf*	*Fresh fruit*	*Dry fruit*
Garcinia cowa	0.89	3.67	5.5
G. pedunculata	1.08	2.10	3.8
G. lanceaefolia	2.45	3.0–4.5	4.0-5.8
G. oxyphylla	0.06	0.01–0.25	0.01-1.0
G. xanthochymus	Nil	Nil	Nil

Source: Parthasarathy *et al.* (2013)

Sources of Protein

Proteins are the important constituent of tissues and cells of the body. They form the important components of muscle and other tissues and vital body fluids like blood. The proteins in the form of enzymes and hormones are concerned with a wide range of vital metabolic processes in the body. Proteins supply the bodybuilding material and make good the loss that occurs due to wear and tear (Gopalan *et al*., 1994). Proteins, as antibodies, help the body to fight against infections. Thus, proteins are one of the most important nutrients required by the body and should be supplied in adequate (60 g for male and 50 g for female) amount in the diet (Gopalan *et al*., 2004). Following underutilized fruits is a rich source of protein (Table 3).

Sources of Fat

Fat is an essential component of the diet and serves a number of functions in the body. Fat is a concentrated source of energy and it supplies per unit energy more than twice the energy furnished by either protein or carbohydrate. It also imparts palatability to a diet and retards stomach-emptying time. The essential fatty acid requirement has been placed at 3–6% of total energy intake depending on the age and

Table 3: Protein content of some underutilized fruits

Common name	*Botanical name*	*Content*
Bael	*Aegle marmelos*	1.80 mg/100 g
Karonda	*Carissa carandas*	0.39 mg/100 g
Aonla	*Emblica officinalis*	0.50 mg/100 g
Jamun	*Syzygium cumini*	0.70 mg/100 g
Amora	*Spondias mangifera*	21.0 mg/100 g
Pora amlakhi	*Phyllanthus acidus*	0.60 g/100g
Poniol	*Falcourtia jangomas*	1.04 g/100 g
Soh Lyngdkhur	*Morus indica*	0.10 g/100g
Soh Phienam	*Myrica nagi*	2.65 g/100g
Soh Phienam	*Myrica esculenta*	2.65 g/100g
Sohiong	*Prunus nepaulensis*	1.95 g/100g
Humra guti	*Terminalia belirica*	3.81 g/100g
Lateku	*Baccaurea sapida*	0.80 g/100g
Sohlang	*Eleagnus latifolia*	0.98 g/100g

Source: Goplalan *et. al.* (2004); Seal (2011)

physiological state (Gopalan *et al.,* 1994). During growth, pregnancy, and lactation, essential fatty acid requirements are relatively higher. To obtain this level of essential fatty acid in the diet, the visible fat intake should be 15–25 g/day in terms of oil content of fruits and other food products. Fat is a major nutritional concern in poor societies, especially in lower-income rural tribals. Fat deficiency in the body causes phrynoderma (toad skin), weakness, and weight loss (Gopalan *et al.,* 2004). Following underutilized fruits are rich sources of fat (Table 4).

Source of Carbohydrates and Fiber

Carbohydrates are a class of energy-yielding substances which include starch, glucose, cane sugar, sugar, etc. Starch is a complex carbohydrate made up of glucose units. Glucose derived from starch and other sugars present in the diet is the main source of energy in the body. Carbohydrates derived from different underutilized fruits form chief source of energy in Indian diets, especially in tribal areas. Generally, energy requirement depends on the age and nature of work (Gopalan *et al.,* 1994). Carbohydrate deficiency in the body causes weakness, weight loss, and reduced physical activity. Following underutilized fruits are rich source of carbohydrate and fiber (Table 5).

Sources of Energy

Energy is essential for rest, activity, and growth. It is well known that even when the body is at rest, it expends a certain amount of energy for essential functions such as respiration, blood circulation, digestion, absorption and excretion, maintenance of body temperature, etc. The three components of foods, which provide this energy, are carbohydrates, fat, and protein. Proteins normally supply 10–12% of energy in most diets; energy that carbohydrate and fat contribute may vary from diet to diet. It is desirable that the energy from fat should not exceed 30% and rest may be derived from carbohydrate (60%). The daily diet of an adult doing moderate work should provide at least 2875 Kcal for male and 2225 Kcal for female (Gopalan *et al.,* 2004). Following underutilized fruits are a rich source of energy (Table 6).

Source of Vitamins:

Vitamins are organic substances present in small amount in

Table 4: Crude fat content of some underutilized fruits

Common name	*Botanical name*	*Content*
Bael	*Aegle marmelos*	0.2 g/100 g
Karonda	*Carissa carandas*	2.6g/100 g
Aonla	*Emblica officinalis*	0.1g/100 g
Jamun	*Syzygium cuminii*	0.15g/100 g
Soh Lyngdkhur	*Morus indica*	0.48 g/100g
Soh Phie	*Myrica nagi*	1.40 g/100g
Soh Phienam	*Myrica esculenta*	1.36 g/100g
Sohiong	*Prunus nepalensis*	0.44 g/100g
Humra guti	*Terminalia belirica*	1.55 g/100g
Lateku	*Baccaurea sapida*	0.10 g/100g
Poniol	*Flacourtia jangomas*	0.13 g/100g
Sohlang	*Eleagnus latifolia*	0.06 g/100g

Source: Goplalan *et. al.* (2004); Seal (2011)

Table 5: Carbohydrate and fiber content of some underutilized fruits

Common name	*Botanical name*	*Carbohydrate*	*Fiber*
Bael	*Aegle marmelos*	31.8 g/100g	3.0 g/100 g
Karonda	*Carissa carandas*	0.5 g/100g	0.6 g/100 g
Aonla	*Emblica officinalis*	15.0 g/100g	1.9 g/100 g
Jamun	*Syzygium cuminii*	14.0 g/100g	0.3 g/100 g
Soh Lyngdkhur	*Morus indica*	8.10 g/100g	0.10 g/100g
Soh Phienam	*Myrica nagi*	21.83 g/100g	2.15 g/100g
Soh Phienam	*Myrica esculenta*	21.55 g/100g	1.44 g/100g
Sohiong	*Prunus nepalensis*	26.96 g/100g	1.70 g/100g
Humra guti	*Terminalia belirica*	34.40 g/100g	2.14 g/100g
Lateku	*Baccaurea sapida*	7.47 g/100g	2.93 g/100g
Poniol	*Flacourtia jangomas*	2.00 g/100g	1.63 g/100g
Pora amlakhi	*Phyllanthus acidus*	3.11 g/100g	-
Sohlang	*Eleagnus latifolia*	9.39 g/100g	1.18 g/100 g

Source: Goplalan *et. al.* (2004); Seal (2011)

Table 6: Energy content of some underutilized fruits

Common name	*Botanical name*	*Kcal/100g pulp*
Bael	*Aegle marmelos*	137 .00
Karonda	*Carissa carandas*	42.00
Aonla	*Emblica officinalis*	65.00
Jamun	*Syzygium cuminii*	62.00
Soh Lyngdkhur	*Morus indica*	37.12
Soh Phienam	*Myrica nagi*	110.52
Soh Phienam	*Myrica esculenta*	109.04
Sohiong	*Prunus nepalensis*	189.80
Humra guti	*Terminalia belirica*	166.79
Lateku	*Baccaurea sapida*	33.98
Poniol	*Flacourtia jangomas*	13.57
Sohlang	*Eleagnus latifolia*	42.02

Source: Goplalan *et al.* (2004); Seal (2011)

many foods. They are required for carrying out many vital functions of the body and many of them are involved in the utilization of the major nutrients like proteins, fat, and carbohydrates. Although they are needed in small amounts, they are essential for health and well being of the body. Following underutilized fruits are rich source of vitamins (Table 7, 8).

Source of Minerals:

A large number of minerals and trace metals are present in the body. Some of these form parts of body structural component and some others act as catalytic agents in many body reactions. Bones and skeleton are made up of mainly calcium, magnesium, and phosphorus, and iron is a component of blood. Minerals like zinc, molybdenum, copper, manganese, and magnesium are either structural part or activate a large number of enzyme systems. Following underutilized fruits are rich source of minerals (Table 9).

Sources of antioxidants:

Fruits are rich with antioxidants that help in lowering incidence of degenerative diseases such as cancer, arthritis, arteriosclerosis, heart disease, inflammation, brain dysfunction and acceleration of the aging process. Antioxidants are substances that can prevent or delay oxidative damage of lipids, proteins and nucleic acids by reactive oxygen species, which include reactive free radicals such as superoxide, hydroxyl, peroxyl, alkoxyl and non-radicals such as hydrogen peroxide, hypochlorous, etc. They scavenge radicals by inhibiting the initiation and breaking chain propagation or suppressing the formation of free radicals by binding to the metal ions, reducing hydrogen peroxide, and quenching superoxide and singlet oxygen (Shi *et al.*, 2001). The most abundant antioxidants in fruits are polyphenols, and vitamin C, vitamins A, B and E and carotenoids are present to a lesser extent in some fruits. Underutilized fruits are sources of many active compounds which shows antioxidant activity. Kaempherol, quercetin, rutin, phyllemblin are active compounds found in aonla, carambola is rich in oxalic acids, while marmelosin is the active compound present in bael. Poniol are rich source of lutein, zeaxanthin. Antioxidant activity of some underutilized fruits are as follows (Table 10).

Table 7: Vitamin 'C' content of some underutilized fruits

Common name	*Botanical name*	*Mg/100 g pulp*	*Common name*	*Botanical name*	*Mg/100 g pulp*
Aonla	*Emblica officinalis*	500-625	Lateku	*Baccaurea ramiflora*	12.1
Ber	*Ziziphus mauritiana*	39-166	Pora Amlokhi	*Phyllanthus acidus*	20.8
Bael	*Aegle marmelos*	8.6	Poniol	*Flacourtia jangomas*	25.6
Karonda	*Carissa carandas*	9.0	Amora	*Spondias mangifera*	19.7
Jamun	*Syzygium cumini*	6.0	Monkey jack	*Artocarpus lakoocha*	14.0

Source: Goplalan *et. al.,* 2004; Shajib *et al.* (2013)

Table 8: Other vitamin content of some underutilized fruits

Common name	*Botanical name*	*Vitamin A (IU)*	*Thiamine (mg/100 g pulp)*	*Riboflavin (mg/100 g pulp)*
Bael	*Aegle marmelos*	91.6	0.13	1.19
Jamun	*Syzygium cuminii*	80.0	0.03	0.01
Karonda	*Carissa carandas*	1619.0	0.04	0.07
Aonla	*Emblica officinalis*	91.6	0.03	0.05

Source: Goplalan *et al.,* 2004

Table 9: Mineral content of some underutilized fruits

		Mg/100 g pulp			
Common name	*Botanical name*	*Ca*	*P*	*Fe*	*K*
Monkey jack	*Artocarpus lakoocha*	66.6	22.1	0.77	350.0
Lateku	*Baccaurea ramiflora*	52.2	17.1	1.48	198.1
Pora amlokhi	*Phyllanthus acidus*	10.8	5.7	1.16	104.4
Poniol	*Falcourtia jangomas*	61.5	12.4	0.93	212.2
Soh Lyngdkhur	*Morus indica*	975	-	30.9	1086
Soh Phienam	*Myrica nagi*	423	-	41.7	763
Soh Phienam	*Myrica esculenta*	463	-	40.4	775
Soh long	*Prunus nepalensis*	7.0	-	2.13	1175
Humra guti	*Terminalia belirica*	526	-	8.23	728
Karonda	*Carissa carandas*	21.0	48.0	28.0	-
Jamun	*Syzygium cuminii*	8.0	15.0	1.2	55.0
Aonla	*Emblica officinalis*	50.0	20	1.2	225
Bael	*Aegle marmelos*	85.0	50	0.7	600
Mulberry	*Morus alba*	70.0	30	2.3	-
Lateku	*Baccaurea sapida*	158.0	-	75	730
Sohlang	*Eleagnus latifolia*	1470.0	-	180	910
Silikha	*Terminalia chebula*	811.0	-	31	1270

Source: Gopalan *et. al.* (2004); Seal (2011); Shajib *et. al.* (2013)

Source of ayurvedic medicine

Underutilized fruits are a major source of raw material for drugs and traditional medicines. It is widely accepted that underutilized fruit produces are of explicit quality with great nutritional, medicinal, organoleptic, economic, and traditional importance. A number of underutilized fruits is a source of valuable remedies of dreaded modern ailments such as cancer, diabetes, jaundice, asthma, and nutritional deficiency. In India, the fruit of aonla, bahera, and hard are the most common entering in to 219 patented drugs. Bael is also used in 60 patented drugs. Aonla is the component of most famous ayurvedic medicine chyavanprash. Ber is used in joshanda, jamun seed in diabetes, and black mulberry in the docking of AIDS virus on human cell. Fruits, nuts, and vegetables in the daily diet have been strongly associated with reduced risk for some forms of cancer, heart disease, stroke, and other chronic diseases (Quebedeaux and Bliss, 1988; Quebedeaux and Eisa, 1990; Wargovich, 2000). Some components of fruits (phytochemicals) are strong antioxidants and function to modify the metabolic activation and detoxification/ disposition of carcinogens, or even influence processes that alter the course of the tumor cell (Wargovich, 2000) (Table 11).

Underutilised fruit for source of sustainable income

Underutilized fruits are the source of sustainable income in rural areas. A number of plant produce (root, leaves, fruits, gum, etc.) has high economic value in the market. The tribal (women and children) and weaker sections of the society collects these fruits and useful part of the plants from the widely scattered trees and bushes in the region from time to time during the season. A part of their collection is retained for their own consumption as raw or in dried form and surplus is sold to the local traders and roadside (Jain, 2003). The market of underutilized fruit in turn is influenced by a number of factors like consumer preference, processability, value addition, export, domestic consumption, foreign demand which again is based on our knowledge about the health-promoting qualities and nutritional value of the crops (Chundawat, 2003). The global forum on agriculture research (GFAR) in 1999 also emphasized the role of underutilized species in raising the income of the rural poor.

Value addition of underutilized fruits

Accurate statistics with regard to the quantity produced and processed is unavailable for underutilized fruits because a

Table10: Antioxidant activity of some underutilized fruits

Botanical name	*DPPH (% Inhibition)*	*Botanical name*	*DPPH (% Inhibition)*
Aegle marmelos	95.18	*Terminalia chebula*	98.97
Flacourtia jangomas	98.20	*Spondias pinnata*	60.39
Syzygium cumini	92.06	*Phyllanthus acidus*	98.10
Carissa carandas	73.86	*Ziziphus mauritiana*	74.96
Garcinia pedunculata	91.97		

Source: Sharma *et. al.* (2013); Mudoi *et. al.* (2012)

Table 11: Therapeutic uses of some underutilised fruits

Common name	*Botanical name*	*Therapeutic uses*
Aonla	*Emblica officinalis*	Hemorrage, diarrhea, dysentery, anemia, urinary problems
Bael	*Aegle marmelos*	Appetizer, stomachic, restorative , laxative, digestive
Jamun	*Syzygium cumini*	Diarrhoea, diabetes, stomachic, carminative, diurectic. Seed powder cure ring worm
Karonda	*Carissa carandas*	Antiscorbutic, root extracts for lumbago, chest complaints and venereal disease
Ber	*Ziziphus mauritiana*	Powder of roots to cure ulcers, fever and wounds
Amora	*Spondia mangifera*	Dysentery, vomiting, indigestion
Soh Lyngdkhur	*Morus indica*	Fever treatment, leaves decoction for throat infection
Soh Phie	*Myrica nagi*	Dysentery
Soh Phienam	*Myrica esculenta*	Bark carminative, antiseptic, decoction used in asthama, fever, bronchitis, dysentery, toothache. Leaf, bark, root fruit used for worms, jaundice, dysentery
Soh long	*Prunus nepalensis*	Leaves diuretic
Humra guti	*Terminalia bellirica*	Seeds for gastritis, stomach disorder. Fruits for piles, dropsy, lepsory, dyspepsia, headache
Seabuck-thorne	*Hippophae salicifolia*	Fruit, pulp and bark in treatment of skin diseases, boils, blisters, asthma, jaundice, stomach or gastric disorders

Source: Mitra *et. al.* (2008); Das and Prakash (2009); Mitra *et. al.* (2010); Seal (2011)

sizeable quantity of the fruits produced is self-consumed, exchanged, or sold locally. The majorities of fruit species in the northeast are not cultivated on a large-scale or commercial basis, but rather are grown in the wild or home gardens or field boundaries. Usually, the fruits are collected from the wild forest and sold fresh on a seasonal basis, with limited processing (Azam-Ali, 2003). The volume processing is very high for all the species, as it refers to primary processing, which mainly involves the removal of pulp and drying. The socioeconomic status of rural families can be improved through value addition of underutilized fruits. It can facilitate optimum utilization of available resources and can have a great future in wasteland fruit production. Value addition will also generate the required employment potential for tribal workers. The technique of value addition, involves the processing of horticultural raw material to create edible or usable forms, easily transpor forms, improves storage and shelf life of the products. Processing of arid fruits and vegetables into more useful and convenient products ultimately improves the economic value of any product, which is the most vital component of value addition (Goyal and Sharma, 2006) (Table 12).

Many of the underutilized temperate pome fruits have multipurpose uses as fruits, timber, fuel, wood for carving, agricultural implements, local articles and also have therapeutic and medicinal properties, but are underexploited due to lack of awareness of their potential and market demand (Table 13).

Besides this, some of the underutilized fruits have other uses also. Jackfruit wood is used as timber for furniture, fruit peel, and leaves as livestock feed and latex used for resins. Bael peel is excellent cattle feed, aonla can be used for dyes and tanning. Milky white latex from unripe karonda fruits used as chewing gum, rubber. Fruits also used for dyeing and tanning. Karonda wood used for spoon and comb making (Mitra *et al.* 2010).

Ecological and environmental conservation

Many of the underutilized fruit crops species can tolerate drought, the shallowness of soil profile, winter and summer hardiness and can be grown in wastelands (Table 14).

Marketing status

Underutilized fruits are generally sold immediately after harvest due to their storage problem and perishable nature. These fruits are mostly sold in the weekly and daily market. The main marketing channels are - producer-trader-retailer-consumer, producer-retailer-consumer, producer-consumer. There is often a high price gap between producer and consumer level (Rathore (2002).

Constraints

Some of the constraints relating to cultivation, utilization, improvement of underutilized fruit crops are as follows -

- Unavailability of suitable agro-techniques
- Unavailability of standardized propagation methods
- Unavailability of improved varieties
- Low yield
- Highly perishable nature
- Available at local markets only

Table 12: Processed products from underutilised fruits

Name of processed products	*Name of fruits*
Jam	*Syzygium cuminii, Carissa carandas, Emblica officinalis, Artocarpus heterophyllus, Aegel marmelos, Zizyphus mauritiana, Morus alba, Averrhoa carambola, Prunus nepaulensis, Hippophae salicifolia*
Jelly	*Syzygium cuminii, Carissa carandas, Flacourtia jangomas, Prunus nepaulensis*
Preserved	*Zizyphus mauritiana, Emblica officinalis, Aegel marmelos, Carissa carandas*
Candy	*Emblica officinalis, Zizyphus mauritiana, Carissa carandas*
Murrabah	*Emblica officinalis*
Juice/beverages/squash	*Aegel marmelos, Syzigium cuminii, Carissa carandas, Grewia subinaequalis, Zizyphus mauritiana, Emblica officinalis, Morus alba, Prunus nepaulensis, Hippophae salicifolia*
Wine	*Carissa carandas, Zizyphus mauritiana, Ficus spp. Syzygium cuminii, Prunus nepaulensis, Hippophae salicifolia*
Chutney	*Carissa carandas, Emblica officinalis*
Sauce	*Carissa carandas*
Pickle	*Emblica officinalis, Zygiphus mauritiana, Carissa carandas, Myrica nagi, Artocarpus heterophyllus, Averrhoa carambola, Elaeocarpus floribundus, Spondias mangifera*
Dehydration	*Aegel marmelos, Artocarpus heterophyllus, Carissa carandas, Grewia subinaequalis, Zigyphus mauritiana, Morus alba, Emblica officinalis*
Canning	*Zygyphus mauritiana, Emblica officinalis, Syzygium cuminii*
Confectionery	*Emblica officinalis, Artocarpus heterophyllus*
Fibre	*Artocarpus chaplasa, Artocarpus, lakoocha*
Dye	*Baccaurea sapida, Garcinia lancaefolia, Myrica nagi, Prunus nepaulensis*

Source: Deka *et al.,* (2012); Goyal and Sharma (2009), Sen (2003); Pareek and Sharma (1993)

Table 13: Use of underutilized temperate fruits

Botanical name	*Family*	*Uses*
Malus baccata	Rosaceae	Fresh, chutney, pickle. Wood for small implements. rootstock
Malus sikkimensis	Rosaceae	Fresh
Pyrus pashia	Rosaceae	Fresh, Leaves fodder, woods as household items. Fruits cure dysentery & laxative
Sorbus aucuparia	Rosaceae	Fresh
Sorbus cuspidata	Rosaceae	Fresh, wood for furniture
Docynia hookeriana	Rosaceae	Fresh fruits consumed and made tarts
Docynia indica	Rosaceae	Fresh
Cydonia oblonga	Rosaceae	Fresh seeds for bile reduction

Source: Gupta (2011)

Table 14: Underutilized fruit crops for marginal areas

Marginal areas	*Underutilized fruit crops*
Degraded forest land	Jackfruit, custard apple, bread fruit, hog plum, governor's plum
Water logged marshy land	Alligator apple, bael, amora
Sandy waste land	Bread fruit, wild ber, star apple, custard apple
Gullied and runoff area	Governor's plum, bael, jamun, wild ber, custard apple, mulberry, tamarind, hog plum
Salt affected land	Wild ber, alligator apple, jamun, governor's plum
Degraded pasture and grazing land	Aonla, tamarind, jamun, star apple

Source: Singh *et al.* (2012)

- Low awareness about nutritive and medicinal values
- Unavailability of suitable post harvest management practices
- Limited and inadequate marketing support

Strategies for development

- The strategies for the development of underutilized fruits can be summarized as follows -
- Ecogeographic studies and genetic diversity survey
- Selection of suitable varieties
- Development of agro-techniques
- Investigation on floral biology
- Work on nutritional value
- Post-harvest management

- Development of value-added products
- Afforestation program in waste and degraded areas
- Incentive for cultivation
- In situ Conservation
- Ex-situ Conservation
- Development of Advanced Technologies for Conservation - cryopreservation

Conclusion

Northeast India is blessed with huge plant genetic resources, especially underutilized fruit (UUF) crops. Systematic cultivation of fruit crops is very low as compared to total crops available in the state. These crops are playing a vital role in providing food security, nutritional security, health security, livelihood and economic security to poor masses in tribal areas. Their commercial importance, nutritional status and market value are unknown to the rural community. There is tremendous scope to popularize these in non-traditional areas, and these crops may be useful raw materials for food processing industries. Further, the huge genetic diversity in various fruit crops offers vast scope for collection, conservation, breeding and improvement for benefit of rural and tribal communities of northeast India. The increase in area and production of these fruit crops will provide nutritional security, save money and export of fresh fruit crops and boost the region's economy. These fruit crops also provide many-fold employment opportunities in agro-based industries, packaging, storage, preservation, canning and transportation.

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