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17 Under-Exploited Fruits of the Forests: Eastern Indian Plateau is a Potential Hub

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17.1 INTRODUCTION

The topography of Jharkhand state is generally undulating, characterized by light textured soil and high rate of soil erosion (Gulati and Rai, 2014). The state is having rainfed condition where the rice based cropping system is the prevalent practice. The soils in this region are low in organic carbon, available phosphorus content and deficient in micronutrients *viz.*, Boron and Zinc. Under these conditions, the productivity of majority of agricultural crops is low leading to nonprofitability of upland agriculture (Dey and Sarkar, 2011). Somehow, the rural and the tribal farmers of this state are partially dependent on forest as a major source for food, fuelwood, fodder, timber and other Non-Timber Forest Products (NTFPs). The state of Jharkhand has 32.0 % (2.5 million ha) of the total geographical area under forest, where per capita forest area of the state is estimated as 0.088 ha and comprises mainly of Sal (*Shorea robusta*) and mixed deciduous forest (FSI, 2011). The state is located in eastern central India on southern side of the river Ganga. The state is also well known for its rich coal reserves and large forest cover. It has 4.21% of total geographical area under tree green cover in agroforestry. Among various states of Eastern India (Eastern UP, Bihar, Jharkhand, Odisha, Chhattisgarh, West Bengal and Assam), Jharkhand has the highest area under wastelands/degraded lands (14.84%), followed by Assam (11.20%) and Odisha (10.69%). There is widespread poverty in the state, with an estimated 44% of the state population living under the national poverty line (World Bank, 2007).

Since time immemorial, the people dwelling in and around the forests mainly depend on forest resources as a mean of food, nutritional and livelihood security. Due to their high dependency on the forest, the forest ecosystem is getting deteriorated day by day. The main reason is the development of industries, expansion of cities (*i.e.*, urbanization), forest degradation, *etc.* which is causing problems in ensuring food and livelihood security. On the other hand, uncontrolled grazing is also leading to reduction of regeneration of the forest species. Moreover, given the population pressure

and its demands, the forest area and its resources are shrinking day by day. It is resulting into seasonal variations and climate change with respect to declines in annual rainfall and thus, leading to water scarcity in the state. Due to this, large-scale mass migration of rural/tribal people is taking place towards urban areas. The concentration of carbon-di-oxide (CO₂) in the atmosphere is increasing day by day, leading to global warming.

The livelihood improvement and adaptation to climate change can only be possible through suitable land-use practices. Forest is one of the important ecosystems of the earth which may potentially support livelihoods improvement through simultaneous production of food, fodder, fuelwood and other Non-Timber Forest Products (NTFPs) as well as mitigation and adaptation to climate change. Since forest is required to meet out the requirements of tribal as well as non-tribal families to a great extent, efforts should be made to conserve such species in the forest which can provide them the basic needs like food (fruits), fodder, fuelwood, timber and NTFPs. Hence, there is a pressing need to conserve the forest and its biodiversity from the variety of risks leading to extinction of important species. Special attention should be given to control illegal felling of trees in the forest and to improve the environmental health by making awareness towards afforestation and reforestation, so that the associated people can lead their lives happily.

17.2 IMPORTANCE OF MINOR FRUITS OF THE FOREST

Among all the species found in the forest regime, few species are the important source of minor fruits. Edible wild fruits have played a very vital role in supplementing the diet of the native people of Jharkhand. Apart from customary use as food, wild edible fruits have various health benefits *i.e.*, increases the immunity against various diseases *etc.* The Indian indigenous medicinal system is based on such wild fruits and plants. The wild edible/minor fruits refer to the species that are neither cultivated nor domesticated, but harvested from their wild natural habitat and used as a diet diversification (Beluhan and Ranogajec, 2010). There is another category of crops called minor fruit crops that have been domesticated but not cultivated in commercial scale like *Aegle marmelos*, *Dillenia sp.*, *Carissa carandas*, *Feronia limonia*, *etc.* Some fruit crops are considered minor in some places while the same fruit crops are in commercial cultivation in some other regions. Therefore, the words minor and major are relative terms only (Paul, 2013). In addition to the role in food security during drought or scarcity, wild edible fruits play an important role in maintaining livelihood and nutritional security of native communities in the developing countries (Afolayan and Jimoh, 2009). It has been reported that wild fruits are sources of vitamins, minerals, fiber, antioxidants and compounds of nutritional importance, secondary metabolites such as alkaloids, essential oils, phenols, tannins, *etc.* Many workers had found that, the wild edible plants are the sources of minor fruits, which play a very important role in the livelihoods and nutritional security particularly in the developing countries. The eastern states of India like West Bengal, Odisha, Bihar, Jharkhand, Assam and other north eastern states are the

treasure houses of wild uncultivated minor fruits. These fruits are comparatively higher in nutrient content than the mainstream fruits and these constitute significant portion of daily diet of the people of Sub-Himalayan, Himalayan and Lateritic zones of West Bengal, Jharkhand and Odisha.

17.3 IMPORTANT MINOR FRUITS OF FOREST OF JHARKHAND

In Jharkhand, the minor fruits obtained from forest provide nutritional and livelihood security to many tribal and native communities. Among all the species of forest, few important minor fruit species are mentioned below:

1. Mahua (*Madhuca longifolia* (Koenig) J.F. Macribide)
2. Kend/ Tendu/ Timroo (*Diospyros melanoxylon* Roxb.)
3. Piar/ Chironji (*Buchanania lanzan* Spreng)
4. Jamun (*Syzygium cumini* (L.) Skeels)
5. Kat-Jamun (*Syzygium fruticosum* (Roxb.) DC.)
6. Indian Jujube/ Ber (*Ziziphus mauritiana* Lam.)
7. Bael (*Aegle marmelos* (L.) Corr.)
8. Indian Hog Plum / Amra (*Spondias dulcis* L.)
9. Monkey Jack Fruit (*Artocarpus lakoocha* Roxb.)
10. Elephant Apple/ Chalta (*Dillenia indica* Linn.)
11. Dog Teak (*Dillenia pentagyna* Roxb.)

17.3.1 Mahua (*Madhuca longifolia* (Koenig) J. F. Macribide)

Mahua, the Indian Butter Tree is an important tree belongs to the family Sapotaceae, which is found many of the forest areas throughout the tropical and subtropical region of the Indian sub-continent. It is a deciduous tree that grows widely under dry tropical and subtropical climatic conditions. It is very hardy and thrives well on rocky, gravely, saline and sodic soils, even in pockets of soil between crevices of barren rock (Singh, 1998). It is commonly found in eastern Uttar Pradesh, Madhya Pradesh, Chattisgarh, Maharashtra, Bihar, Jharkhand, Odisha, Andhra Pradesh and Gujarat. In Jharkhand, it is also found to be grown on different types of wastelands.

The tree is having vital socio-economic value because of its flowers, fruits and seeds, which are the largest source of natural hard fat commercially known as 'mahua butter' or 'mowrah butter'. Fruits are green at maturity and turn pinkish yellow when ripe. Botanically fruit is fleshy berry. Fruits are 2-6 cm long, ovoid, fleshy and having 1-4 seeds, coloured brown to black. The edible part is mesocarp (flesh) and eaten as raw or cooked. The fruit pulp may be utilized as a source of sugar, whereas, the dry husk makes a good substrate for alcoholic fermentation. Seed contains two kernels. Seeds of mahua are highly sensitive to desiccation and freezing, indicating recalcitrant nature of seed. They are good source of oil (Singh *et al.*, 2005). The oil obtained from kernel (20-50 %) is edible and also used for preparation of vegetable oil (Puhan *et al.*, 2005). Amount of oil obtained from seeds of the fruit is higher than many oil seed crops and oil bearing trees. In mahua oil, linoleic and unsaturated fatty acids are found, which are useful for heart patients, as it reduces the cholesterol content in blood serum. Mahua oil is also used in manufacture of soaps,

lubricating grease, fatty alcohols and candles. The native communities, particularly the tribals, collect the fallen corolla and consume it in the fresh or dried form. Flowers of the plant are edible. The corolla is a rich source of sugar containing many vitamins and minerals (Singh and Singh, 2005). The flowers are also used in preparation of distilled liquor, portable spirits, vinegar and as feed for livestock (Adhikary and Adhikary, 1989). Nutritive value of mahua flower has been presented in the TABLE 17.1. The leaves are used for making plates for various purposes. *Mahua* seeds can also be used for preparation of defatted flour, which has great potential in bakery products. The saponin obtained after extraction has industrial and commercial application. Cake obtained after extraction of oil is used as manure and has insecticidal properties. High sugar content of mahua flower allows it to be consumed as jam, jelly or even raw. Every part of *mahua* yields an economic product of great potential value. Hence, it is very useful tree for tribals and poor native communities of the state. People in small villages don't have sufficient money for various resources to earn their living that is why they are fully or partially dependent on the natural resources which are easily available, cheap and renewable. The *mahua* flowers/fruits production in India is mainly concentrated in the drier states and the produce is collected by the villagers and sold in the local market. Its cultivation may be spread to arid and semiarid areas, resource poor areas and wastelands where other crops can not be grown successfully. The rate of seed setting in mahua under normal environmental conditions is very low. The matured fruits fall on the ground during May-July month in the North and eastern India and August-September in the South India.

Large-scale cultivation of *mahua* is one of the major constraints because of its long gestation period. Recently, the techniques have been developed to produce grafted plants of *mahua* which start bearing in the fourth year. Looking at the economics and short gestation period, farmers are now keen to establish plantation of *mahua* on their degraded lands as a commercial crop. There is hardly any breeding related work or tree improvement programme carried out in this crop. Thus, there is scope for improving the available planting materials of this species through suitable breeding programme.



Fruits of Mahua

TABLE 17.1: Nutritional Properties of Mahua Flower

Sl. No.	Constituents	Value
	Moisture (%)	19.80
	Protein (%)	6.37
	Fat (%)	0.50
	Reducing Sugar (%)	50.62
	Total Inverts (%)	54.24
	Cane Sugar (%)	3.43
	Total Sugar (%)	54.06
	Ash (%)	4.36
	Calcium (%)	8.00
	Phosphorus (%)	2.00

Source: Kureel *et al.*, 2009.

17.3.2 Kend/ Tendu/ Timroo (*Diospyros melanoxylon* Roxb.)

Kend, Coromandel Ebony or East Indian Ebony or Timroo or Tendu (*Diospyros melanoxylon* Roxb., Syn. *D. tupru* Buch. Ham.), belongs to the family Ebenaceae, which is distributed through Indian, Nepal and Pakistan. *D. melanoxylon* is native and endemic tree of India and widely found in the peninsular plains and lower hills especially in the dry deciduous forests of central, western and northern India (Stewart and Brandis, 1992). It grows in plains and plateaus and sub-mountain regions and also in the plains of sub-humid regions (Pareek and Sharma, 1993). It is successfully grown in the areas receiving rains between 500 - 1500 mm per annum. This species serves as indicator of high sulphur-di-oxide concentration (Singh *et al.*, 2007) and is one of the most common species of forests of Madhya Pradesh, Bihar, Jharkhand, Chhattisgarh, Rajasthan, Gujarat, Orissa, Andhra Pradesh and Tamil Nadu (Malik *et al.*, 2010).

This plant has been well documented in Ayurveda and Unani texts and also used ethnobotanically for its multipurpose use in different diseases. The whole plant is medicinally important and cures several diseases. Flowering and fruiting in India occur from January to August. Flowering starts 5 to 6 years after plantation (Sen, 2003). The flowers appear from April to June on new shoots and the fruit ripens after one year leading to alternate bearing (Janik and Paull, 2008). The dried flowers of the tree possess medicinal values and are reported to be useful in urinary, skin and blood diseases (Hocking, 1993).

The fruits of this species have been reported to be collected for trade and weekly consumption (Kala, 2013). The people from Jharkhand sell the fruits during March- June to nearby markets at the average rate Rs. 20 to Rs. 40 per kg. Either the ripened fruits dropped naturally are eaten or the unripe fruits plucked from mother trees are placed in straw of *Cicer arietinum* for 45 days to ripen (Kala, 2013). The fruit is bitter, acrid, cooling, digestible, carminatives and astringent (Kirtikar and Basu, 1993). It is used as an anti-inflammatory and antipyretic drug in many local traditional medicines (Kirtikar and Basu, 1999). The tannin content of ripe fruit is 15% and that of half ripe fruit is 23%

(Malik *et al.*, 2010). Fruits are used in stomach disorders. Since the species is very important considering the value of the fruits, its improvement through breeding programme is of utmost importance for conservation of the best germplasm.



Fruits of Kenda (*Diospyros melanoxylon* Roxb.)

17.3.3 Piar/ Chironji (*Buchanania lanzan* Spreng)

Common name char or chironji belongs to the family Anacardiaceae. It is a non-wood tree species found in deciduous forests throughout the greater part of India and generally attaining a height up to 18.0 m and girth 1.5 m. This is found throughout India, Burma and Nepal. The plant grows on yellow sandy-loam soil and is commonly found in the dry forests of Jharkhand, Madhya Pradesh, Chattisgarh and some parts of Uttar Pradesh. In Madhya Pradesh, it is a common associate of teak, sal and mixed forests. It is used for environmental conservation and in 'agroforestry system'. It is used as a fuel, fodder for buffaloes and alternative host for *Kusmi* lac insect. Its oil is used for cosmetic items and soaps. The oil is also used by tribal as edible oil. Seed/kernel of *Buchanania lanzan* is nutritional, palatable and used as a substitute of almond in confectionery. Kernel yield a fatty oil known as 'chironji oil' which is a substitute for olive and almond oils in both confectionery and indigenous medicines used for glandular swellings of the neck (CSIR, 1986). Fruits are laxative and used to relieve thirst, burnt skin and fever. Kernels of fruits are used as ointment in skin diseases (Das and Agrawal, 1991).

Tree of *Buchanania lanzan* flowers from January to March and fruits ripen in the month of April-June (Troup, 1986). Fruits become red/purple after ripening. The fruit of chironji mature in 4-5 months and the collection takes place from April to June. During May-July, the people sell the ripen fruits at the rate of Rs. 80-100 per kg. Early harvesting may lead to low fruit/seed quality and poor germination potential. In most parts of Jharkhand, fruits are harvested before ripening, which fetches low price in the market because of small seed size and low seed quality. This species can generate income to the people specially the forest dwellers of the state Jharkhand.

Fruit collection should be done during 2nd /3rd weeks of May as during this period fruits have maximum values of oil (61.6 % to 62.0 %), protein (50.2 to 48.0 %) and sugar (3.90 to 3.82 %) [Sharma, 2012]. In natural forests, its

regeneration is very scanty due to unscientific and pre-mature harvesting of its seeds and site degradation on account of growing biotic pressure. Since natural regeneration of the species is very difficult, hence, the species needs extensive conservation to meet out the demands of the people of the state for which high yielding or improved varieties needs to be developed and popularized.

17.3.4 Jamun (*Syzygium cumini* (L.) Skeels)

Syzygium cumini (L.) Skeels; syns. *S. jambolanum* DC, *Eugenia cumini* Druce, *E. jambolana* Lam., *Myrtus cumini* L., *Calyptanthes jambolana* Willd. (common name - Jamun) belongs to the family Myrtaceae, which was first described by Francis Hamilton in 1798. The species is native to India, Myanmar, Sri Lanka and the Andaman Islands (Worthington, 1959) and naturalized in South East Asian countries (Burkill, 1935). The tree is adapted to a wide range of soil conditions. It can survive and grow better under lower salinity and shallow water table conditions (Hebbara *et al.*, 2002) and even in the soils with pH upto 10.5 (Singh *et al.*, 1997).

The tree is fast-growing, reaching full size in 40 years. In India (Jharkhand) the tree blooms from February to April and fruits are harvested from June to August. Small second crops from late blooms have been observed in October. Many workers have reported a harvest of 700 fruits from a 5-year-old tree. Small amount of the ripen fruits are being directly consumed in the rural households and utilized in home as preservatives. On the other hand, large quantities of the fresh fruits are sold at the rate of Rs. 40 - 60 per kg of fruits in the markets of Jharkhand.

Jamun requires dry weather at the time of flowering and fruit setting. The leaves of *S. cumini* have shown antioxidant, anti-allergic, anti-inflammatory and analgesic properties (Ruan *et al.*, 2008). Since the species is having more economic and nutritional values, hence, can be included and planted under suitable agroforestry systems. The nutritional values of the jamun fruit are given in the TABLE 17.2.

TABLE 17.2: Nutritional Value of Jamun Fruit

Nutrient	Nutrient Composition/100g (edible portion)
Moisture (%)	85.25
Titration acidity (%)	0.89
TSS (%)	9.5
Crude fibre (g)	0.85
Total carbohydrate (g)	11.24
Total protein (g)	0.87
Total fat (g)	0.54
Total energy (K cal)	53.30
Vitamin C (mg)	151.51
Beta-carotene (µg)	1112.38
Sodium (mg)	28.0
Potassium (mg)	285.0

Nutrient	Nutrient Composition/100g (edible portion)
Iron (mg)	4.76
Zinc (mg)	1.55
Copper (mg)	1.02
Manganese (mg)	2.62
Phosphorus (mg)	45.39
Calcium (mg)	24.0
Magnesium (mg)	47.0

Source: Jahan *et al.*, 2011.

17.3.5 Kat-Jamun (*Syzygium fruticosum* (Roxb.) DC.)

Syzygium fruticosum (Roxb.) DC., syn. *Syzygium heyneanum* Wall. ex. Wight & Arn., *Eugenia fruticosa* (DC.) Roxb., belongs to the family Myrtaceae which is one of the 1100 species in the genus *Syzygium* and is widely distributed in India, Myanmar, China, Thailand and Bangladesh (Elliot *et al.*, 2010). In Jharkhand, the species is mainly found in the forest. It is used as indigenous remedy for the treatment of stomach-ache, diabetes and bronchitis in some countries (Jain *et al.*, 2010).

Small trees have ash coloured stem and greenish white flowers. The flowering occurs in the month of March-May and ripening of fruits occurs in the month of May-July. This species can grow upto 12-15 m tall. All parts of the species have been reported to have medicinal value. The stem bark is used as an astringent and fruits are used in liver problems (Gaur and Lale, 2015). The fruit is rich in vitamin C and iron and poor in calcium and total carotene. It has significant amount of fiber. Seed extract is traditionally used for controlling diabetes and dysentery. Seeds are dried and powdered and pills prepared from the powder are taken orally in the morning on an empty stomach.

The native communities living in and around the forest collect the fruits and consume as raw. Hardly this fruits are being sold in the market, though it is having high nutritional values. As the fruits obtained are of lesser in quantity and could not find any place in the market, thus this species needs much attention to grow in a wider scale by making available improved planting stock to the forest dwellers and the needy people.

17.3.6 Indian Jujube/ Ber (*Ziziphus mauritiana* Lam.)

Ziziphus mauritiana Lam., belongs to the family Rhamnaceae. It is also called Jujube tree or Ber (Michel, 2002; Rathore *et al.*, 2012), whose, all the parts are very effective against the different types of diseases. Its leaves are useful in the treatment of diarrhoea, wounds, abscesses, swelling and gonorrhoea (Michel, 2002). The leaves of *mauritiana* are also used in the treatment of liver diseases, asthma and fever (Morton, 1987). Carbohydrates, starch, proteins, sugar, mucilages and vitamins are abundantly found in the fruit of this species. Fruits are used in the treatment of liver (Dahiru *et al.*, 2005).

In Jharkhand, the fruiting time is December to March ending and the fruit

colour is red when ripe and the fruit is juicy. The fruit is used as anodyne, sedative, tonic anticancer, potent wound healer and also against asthma. The fruit, leaves and seeds extracts have antioxidant properties, whereas, bark is reported to possess cytotoxicity against different cancer cell lines (Rathore *et al.*, 2012).

Under rainfed conditions in Jharkhand, fruit yield of 50-80 kg per tree can be obtained. The fruits are sold by the farmers in the market at the rate of Rs. 20 - 60 per kg. Sometime prickles are prepared from this fruit and are sold in small packets of 50 g approximately at the rate of Rs. 10 per packet. The only constraint is that, the fruits do not ripe if harvested before ripening and over-ripen fruits lose their eating quality and storability. Therefore, fruits which are just mature and have shining yellow colour should be harvested. At this stage, the fruits contain the desired sugar: acid ratio. The main acid is ascorbic acid. The freshly harvested fruits possess highly nutritional values (TABLE 17.3).

TABLE 17.3: Nutritional Value of Ber Fruit

Nutrient	Nutrient Composition/100g (edible portion)
Energy (Kcal)	74.0
Carbohydrate (g)	17.0
Sugars (g)	5.4 -10.5
Dietary fibre (g)	0.60
Protein (g)	0.8
Fat (g)	0.07
Water (g)	81.6 - 83.0
Thiamine (mg)	0.02-0.024
Riboflavin (mg)	0.02-0.038
Niacin (mg)	0.7-0.873
Iron (mg)	0.76-1.8
Calcium (mg)	25.6
Phosphorus (mg)	26.8

Source: Morton, 1987.

17.3.7 Bael (*Aegle marmelos* (L.) Corr.)

Bael (*Aegle marmelos* Corr.) belongs to the family Rutaceae. It is one of the most important sacred trees of Hindu mythology and has great medicinal value. The tree is indigenous to Indian subcontinent and mainly found in tropical and subtropical regions. In the wild, the tree is found to occur in the foothills of Himalayas, Uttar Pradesh, Bihar, Jharkhand, Chattisgarh, Uttarakhand, Madhya Pradesh, the Deccan Plateau and along the east coast (Purohit and Vyas, 2004). It grows wild in sub-Himalayan tract, Central and South India and Myanmar. It is planted all over India and Myanmar (Gupta, 2016).

The species is a slow-growing, medium sized deciduous tree, which can grow up to 12-15 m tall with short trunk, thick, soft, flaking bark, and spreading, sometimes spiny branches with the lower ones drooping. Young

suckers bear many stiff, straight spines. A clear, gummy sap, resembling gum *arabic*, exudes from wounded branches and hangs down in long strands, becoming gradually solid. It is sweet at first taste and then irritating to the throat. Its trifoliolate leaves are presented to Lord Shiva as offerings by the devotees. The flowers are greenish white, fragrant and the fruit is yellowish brown when ripen with a smooth hard aromatic rind. Marmelosin, a furocoumarins, is the active constituent of fruit which acts as laxative and diuretic in lower doses and as a cardiac depressant in higher doses. The unripe or half ripe fruit is believed to be an invaluable remedy in obstinate cases of chronic diarrhoea and dysentery. The seeds contain bitter fatty oil which acts as purgative. The fruit also contains sugars (4.6%) and tannin (9% in the pulp and 20% in the rind) [Anon., 1956]. Bael is used to cure several ailments like cholera, stomach-ache, dog and snake bite, asthma, scurvy, vomiting, constipation and piles. The nutritional value of the bael fruit is given in the **TABLE 17.4**. Considering the socio-economic and nutritional value of the fruit, the species needs much attention to popularize and upscale its genetic diversity which was although reported by many workers but lacks information about the improved strains. Hence, improved planting materials need to be developed and standardized through suitable breeding programme.

TABLE 17.4: Nutritional Value of Bael Fruits

Components	Value (%)
Water content (Moisture)	64.20
Protein	1.2
Fat	0.2
Mineral	1.5
Fibre	2.2
Carbohydrate	30.6
Calcium	0.09
Phosphorous	0.05
Potassium	0.6
Iron	0.3
Vitamin A (IU)	186
Vitamin B ₁	0.01
Nicotinic acid	0.9
Riboflavin	1.2
Vitamin C	0.01
Calorific value (K Cal)	129

Sources: Purohit and Vyas, 2004; Paricha, 2004.

17.3.8 Indian Hog Plum / Amra (*Spondias dulcis* L.)

Spondias dulcis L. (syn., *S. cytherea* and *S. pinnata*), Malay apple or golden apple or Indian hog plum or Amra, belongs to the family Mangiferaceae. It is an equatorial or tropical tree, with edible fruit containing fibrous pith. The tree is

indigenous to Indian subcontinent and mainly found in tropical and subtropical regions. In India, the tree is naturally found to occur in the foothills of Himalayas, Uttar Pradesh, Bihar, Jharkhand, Chattisgarh, Uttarakhand and many of the forest areas.

This fast-growing tree can reach up to 60 ft (18 m) in height. This species has deciduous, pinnate leaves, 8 to 24 inches (20-60 cm) in length, composed of 9 to 25 glossy, elliptic or obovate-oblong leaflets 2.5 to 4.0 inches (6.25-10 cm) long, finely toothed toward the apex (Morton, 1987a). The tree produces small, inconspicuous white flowers in terminal panicles, assorted male, female. Its oval fruits, 2.5 to 3.5 inches (6.25-9 cm) long, are long-stalked and are produced in bunches of 12 or more. Over several weeks, the fruit fall on the ground while still green and hard, turning golden-yellow as they ripe. The fruit may be eaten raw. The flesh is crunchy and a little sour. Leaves are used as an ingredient for making herbal hair lotion and fruits are used against dysentery and dyspepsia. The fruit is rich in dietary nutritional components (TABLE 17.5). Every part of the plant has many uses. Although the species is economically important, but hardly any improved propagation methods had been reported so far by the workers. Hence, this species needs much attention to conserve and popularize it among the farming community.

TABLE 17.5: Nutritional Value of Amra Fruits

Components	Value (per100 g of edible portion)
Moisture (%)	87.69
Titration acidity (%)	0.9
TSS (%)	13.0
Crude fibre (g)	2.69
Total carbohydrate (g)	6.85
Total protein (g)	1.12
Total fat (g)	0.14
Total energy (K cal)	33.14
Vitamin C (mg)	128.78
Beta-carotene (μ g)	2377.06
Sodium (mg)	23.0
Potassium (mg)	675.0
Iron (mg)	7.62
Zinc (mg)	1.23
Copper (mg)	1.12
Manganese (mg)	3.11
Phosphorus (mg)	116.28
Calcium (mg)	51.0
Magnesium (mg)	38.0

Source: Jahan *et al.*, 2011.

17.3.9 Monkey Jack Fruit (*Artocarpus lakoocha* Roxb.)

Monkey Jack fruit (*Artocarpus lakoocha* Roxb.), locally known as Barhal or Lakuch or Dhau, belongs to the family Moraceae. It is one of the most important tropical trees originating from India. This species is also distributed in other parts of Asian countries like Bangladesh, Bhutan, Nepal, Myanmar, Sri Lanka, Malaysia, Thailand, Vietnam, Singapore, Cambodia, and Laos (Hossain *et al.*, 2016). In India, it is found to grow naturally in forest areas especially in the foothills of Himalayas, Jharkhand, Chattisgarh, most of the hilly areas including Western Ghats. This species is widely used as a medicinal plant by tribals of Jharkhand, India for the treatment of many diseases (Gautam and Patel, 2014).

Flowering in this species occurs in the month of January-March and fruit ripening takes place during June-August. The fruit is highly nutritious (TABLE 17.6) and is consumed by the tribals as vegetable when unripe and raw when ripe. Jahan *et al.* (2011) reported that, the fruit contains vitamins and is excellent source of antioxidants, such as vitamin C, β -carotene and minerals like zinc, copper, manganese and iron. It is used in cosmetic industries as a skin whitening agent.

Fruits of this species play a significant role by providing supplementary nutrient diet and income generation to the people of rural areas, specially the tribals or the forest dwellers of Jharkhand. Considering it as an important source of vitamins, minerals, dietary fibers and polyphenols, the fruits have the direct health benefits. Hence, the fruits of this species need to be explored more to increase awareness among the people to consume for healthy life. This species is highly important in terms of socio-economic and nutritional value, which has a potential to draw attention to the scientific community to conduct more research on this species for popularization as a mainstream fruit crop. Although micropropagation technique had been carried out to produce quality planting materials of this species but had not been reported and popularized by the workers. Hence, there is a need to strengthen the propagation techniques to produce improved planting materials.

TABLE 17.6: Nutritional Value of Monkey Jack Fruit

Components	Value (per100 g of edible portion)
Moisture (%)	84.25
Titration acidity (%)	0.34
TSS (%)	16.0
Crude fibre (g)	2.41
Total carbohydrate (g)	9.47
Total protein (g)	1.03
Total fat (g)	0.71
Total energy (K cal)	48.39
Vitamin C (mg)	171.07
Beta-carotene (μ g)	3718.16
Sodium (mg)	46.0

Components	Value (per100 g of edible portion)
Potassium (mg)	785.0
Iron (mg)	15.09
Zinc (mg)	1.68
Copper (mg)	1.31
Manganese (mg)	3.76
Phosphorus (mg)	66.06
Calcium (mg)	47.0
Magnesium (mg)	55.0

Source: Jahan *et al.*, 2011.

17.3.10 Elephant Apple/ Chalta (*Dillenia indica* Linn.)

Dillenia indica Linn. (Commonly known as Elephant apple or Chalta), a medium sized evergreen tree, grows up to 30 m tall, belongs to the family Dilleniaceae. It is distributed in Bhutan, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, the Philippines, Sri Lanka, Thailand, Vietnam, *etc.* In India, it is found in sub-Himalayan tract, Assam, North Bengal, Bihar, Odisha, Madhya Pradesh, Gujarat (Khanum *et al.*, 2007) and Jharkhand. Flowering occurs in April-June months while fruiting occurs in July- August and ripens in November-December months. Fruits are aggregate and globose, 10-15 cm in diameter, indehiscent, persistent sepals, fleshy, slightly swollen and edible. Fruits contain 5 or more seeds per carpel, which are exarillate, imbedded in glutinous pulp, compressed and have hairy margins (Kirtikar and Basu, 1999a).

Traditionally, whole plant is used against fever, as an aphrodisiac and as virility promoting agent (Gandhi and Mehta, 2013). The extract of root bark cures food poisoning and its paste along with leaf paste is applied externally in sprains and also used as an astringent and antiamphetamine. Stem-bark of the species is used as component of medicine for sores caused by mercury poisoning, chronic sores and carbuncle and as a prophylactic in cholera. Stem extract is used against the spider bite to remove the poison (Gandhi and Mehta, 2013).

The fruits of the species are said to be relished by elephants and hence the name 'Elephant Apple'. The green fruit (unripe) is acidic, sour, bitter, pungent and astringent, but the ripe fruit is sweet, sour, appetizing, tasty, removes 'vata' and 'kapha', dispels fatigue, stops abdominal pains (ayurveda), laxative, beneficial in colic associated with mucous, is apt to induce diarrhoea if too freely indulged in (Khare, 2007). Fruit decoction is used for curing dandruff and checking falling of hairs and also used as tonic to combat weakness. Ripe fruits are eaten fresh as well as cooked, which contains 0.9% total soluble solids. The extracted juice when mixed with sugar and water, serves as a cooling beverage in fever and as a cough syrup. Ripe fruit-juice removes flatulence and helps in increasing quantity of semen, while external application helps in suppuration of boil. The thick and fleshy calyx of fruits used as a flavoring agent and is used to make jams and jellies (Rastogi *et al.*,

2000).

The seeds are covered by fleshy proteinacious aril which is used in curry, pickle and jelly preparations. Seeds, its oil and its unsaponifiable matter have antimicrobial, antifungal and antibacterial properties. It is widely used to garnish the indigenous ayurvedic medicine for nervousness. Mucilage is applied on wounds of burns (Janick and Paull, 2008). The mineral contents in the fruits of the species have been listed in TABLE 17.7. Despite being having highly nutritional values, *D. indica* hardly got any market value. Since, the species has got many ethnobotanical uses, hence, there is a need to conserve or strengthen or develop suitable and quality planting materials through breeding programme (may be through micro-propagation or tissue culture or through vegetative means).

TABLE 17.7: Minerals Content of Chalta Fruit

Components	Value (per100 g of edible portion)
Copper (mg)	0.06 ±0.01
Iron (mg)	0.38 ±0.03
Manganese (mg)	0.06 ±0.03
Zinc (mg)	0.11 ±0.20
Sodium (mg)	0.60 ±0.04
Potassium (mg)	33.06 ±2.22
Calcium (mg)	14.29 ±0.90
Magnesium (mg)	06.56 ±0.26

Source: Sajib *et al.*, 2014.

17.3.11 Dog Teak (*Dillenia pentagyna* Roxb.)

Dog teak is a deciduous tree, growing up to 15 m tall and belonging to the family Dilleniaceae. This species is distributed in rain forests of Bhutan, India, Indonesia, Malaysia, Myanmar, Nepal, Thailand and Vietnam. In India, it is found in the Himalayan terrain, from north western to north eastern states, southern India and the Andamans (Khanum and Khan, 2007; Khare, 2007). The flowering starts in April-May months and fruits are globose in shape, 0.5-1.0 cm in diameter, indehiscent, greenish when fresh and seeds are exarillate (Gandhi and Mehta, 2013).

The powder prepared from the bark is taken with water for curing diabetes, diarrhoea and dysentery. Sugar is mixed with bark powder and given to women for easy delivery and also applied externally to check infection. Bark paste is applied on scalp once a week for healthy hair growth (Gandhi and Mehta, 2013). Leaves are used in case of cut and wounds. The decoction is given for body pain twice a day till cure (Khanum, 2007). This species is available only in forest and rarely cultivated. It is found to have good therapeutic potential so further evaluation needs to be carried out on this species in order to explore the remote areas and their practical pharmacological as well as clinical applications. Fruits are eaten raw or cooked (Saxena and Brahmam, 1995) and have high nutritional value (TABLE 17.8).

TABLE 17.8: Nutritional Value of Dog Teak Fruit

Components	Value (per100 g of edible portion)
Moisture (%)	81.45 ± 0.77
Carbohydrate (%)	18.50 ± 0.99
TSS (%)	16.78 ± 0.35
Protein (%)	0.32 ± 0.11
Iron (mg)	16.00 ± 0.37
Manganese (mg)	12.00 ± 0.16
Copper (mg)	2.20 ± 0.18
Calcium (mg)	4.50 ± 0.32

Source: Nayak and Basak, 2015.

17.4 CONCLUSION

The minor fruits of wild source of the state provide sustainable benefits to the tribals and other native communities in terms of securing their livelihood. However, there are few challenges faced by the people due to insufficient understanding and information regarding the market structures and its functioning *etc.* These are the major hurdles in ensuring remunerative prices to the farmers or people or forest dwellers involved in harvesting of minor/wild fruits trees of forests. Hence, there is a need for linking the market chains through involvement of NGOs, Governments, corporates and farmer's cooperatives. The ecosystem services of different common fruit species like mango, guava, papaya, litchi, *etc.* have already been established and effort should be done for establishments of the same for the minor fruits. The monetary gain and the nutritional values of these minor fruits of forest sources need to be highlighted for attracting small and marginal farmers for adoption of those species as a component of agroforestry system for crop diversification and multiple outputs.

Considering the topography, climate and soil condition of Jharkhand, the native people are generally acquainted with the habit to harvest fruits from the forests for consumption as well as for selling purposes. The fruits of forests play a vital role in the nutritional and livelihood security of the rural and tribal people living in and around the forest.

The minor fruit species of wild sources are rarely cultivated, but when considering its high nutritive and medicinal values, there is an urgent need for strengthening research efforts in identifying improved strains of suitable minor fruit species from wild sources for the state. Strengthening of nursery programme for large-scale availability of quality planting material of improved strains of minor fruit trees can go a long way in covering larger area under tree cover, which will supplement the additional income and nutritional grains to the farmers of the state, Jharkhand. It will also help in sorting out the nutritional needs of ever increasing population and also act as a source of revenue generation to secure livelihoods and food security of the native communities.

17.5 REFERENCES

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