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Tendu (*Diospyros melanoxylon* (roxb))

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1. Introduction

Tendu or Kendu tree (*Diospyros melanoxylon* Roxb.) belonging to Family Ebenaceae, which is endemic to Indian sub-continent. Locally it is known as temburini. It is drought and frost hardy but sensitive to water logging. It is also one of the important lesser known fruits which is available during summer in the local market of Madhya Pradesh, Chattisgarh, Jharkhand and Orissa state and used as a



Tendu-Fruits

delicacy. The fruits are highly nutritive and rich source of phenols and fibre. The tribal of these regions are using this fruit to protect them from loo or hot wind during summer. The generic name is derived from the Greek 'dios' (divine), and 'pyros' (fruit), referring to the excellent fruit of the genus. The specific name is Greek and means 'dark wood'.

1.1. Nutritive Value

The fruits are highly nutritive and rich source of phenols and fibres. Its fruit pulp is yellow, glutinous, soft, sweet and slightly astringent. These fruits are rich in sugars, proteins, fibre and vitamin C. Further, to presence of several benevolent phytochemicals such as β -Carotene, terpenoids, flavonoids, saponin and tannin in the fruit add advantages to its nutritive value (Maridass, 2010). Ripe fruits are important source some non-antioxidants, unidentified oligosaccharide, fumaric acid and gallic acid (Daood *et al.*, 1992). The estimated constituents of ripe fruits have been presented in Table 1 and 2.

Table 1. Chemical composition of tendu pulp

Parameter	Pulp(g/100g)	Juice (g/100ml)
Weight	72.0±2.7	ND
Moisture	68±2.3	ND
Total sugar	28.6±3.0	22.1±1.7
Ascorbic acid (Vit-C)	2.8±0.56	1.78±0.6
Phenol	1.72±0.64	1.36±0.55
β-Carotene	22.0±1.0	18.0±0.27
Ash	0.25±0.04	0.23±0.05

Source: Umesh *et al.*, 2012

Table 2. Constituents of tendu fruits

Constituents in ripe edible pulp	Content
Moisture (%)	79.1-82.4
Protein (%)	0.43-0.58
Crude fibre (%)	0.37-0.49
TSS (° Brix)	16.2-19.5
Glucose (%)	1.05-11.9
Fructose (%)	4.65-6.79
Soluble pectin (%)	4.40-7.29
Soluble tannin (%)	0.50-0.68

Source: Nath *et al.*, 2009

1.2. Uses

This plant has been well documented in Ayurveda and Unani texts and also ethanobotanically for its multi-purpose use in different diseases. Wine can be prepared from tendu fruits as like cashew apple, litchi and others tropical and sub-tropical fruits. have been used extensively in Indian traditional medicine to treat for a variety of diseases including diarrhea, cholera, dysentery, intermittent fevers, bleeding gums, bronchitis, carbuncles, cough, cramps, pneumonia, syphilis, tumors, etc. The tendu leaves are wrapped with tobacco to make Indian *beedi*, (Lal, 2009) which has outsold conventional cigarettes in India. Tendu (*Diospyros melanoxylon*) leaves make excellent wrappers, and the success of the beedi is due, in part, to this leaf.

2. Origin and distribution

Coromandel Ebony or East Indian Ebony (*Diospyros melanoxylon*) is a species of flowering tree in the family *Ebenaceae* that is native to India and Sri

Lanka and that has hard and dry bark. Its common name derives from Coromandel, the coast of southeastern India. According to Troup (1921) *Diospyros melanoxylon* (inclusive of *D. tomentosa* and *D. tupru*) is one of the most characteristic trees of the dry deciduous forests throughout India, covering the entire Indian peninsula the area of distribution extends up to Nepal in sub-Himalayan tracts including the Indian plain, Gangetic plain, Madhya Pradesh, Maharashtra, western coast up to Malabar and Eastern coast up to Coromandel. The plant is also met with on the Nilgiris and Serawalli hills in the south. Locally it is known as *temburini* or by its Hindi name *tendu*. In Odisha and Jharkhand it is known as *kendu*. Genus *diospyrus* belong to family *Ebenaceae* which has more than 400 species distributed over tropical and sub tropical parts of the world.

3. Area or region of cultivation or availability

Tendu plants are naturally occurring in the forest and groves of tropical and subtropical region. It is normally found in dry deciduous forest as a constituent species of *Tectona grandis*, sal and mixed forests of *Acacia leucophlea*, *Boswellia serrata*, *Butea monosperma*, *Lantana coromandelia* and *Terminalia tomentosa*. It is mainly available for its leaves used for Bidi. No systematic plantation has been made so far for fruit production. Therefore, estimated area is not available.

4. Genus and different species

Genus *Diospyros* belongs to family *Ebenaceae* which has more than 400 species distributed over tropical and sub-tropical parts of the world. Arora and Pandey (1996) reported 12 species being found in different parts of India whereas Zeven and Zhukosky (1975) mentioned 8 species in 5 centres of origin. Ito (1980) described 4 major species of *Diospyros* having commercial value. These are *D. Kaki*, *D. Lotus*, *D. Verginiana* and *D. oleifera*.

5. Cytogenetics

Basic chromosome number of *D. melanoxylon* Roxb is $n = 15$ (Gill, 1990), $2n = 30$ (Wallnofer, 2001).

6. Botanical description, growth habit

The tree is deciduous or evergreen depending on its habitat. In a dry locality, it is leafless for a short time in the hot weather, regaining its leaves in May-June. It is evergreen in moist locality. Tendu (*Diospyros melanoxylon*) is a medium-sized tree or shrub up to 25 m, and 1.9 m girth. The bark is pelican in colour, exfoliating in rectangular scales. The primary root is long, thick and

fleshy at first, afterwards woody, grayish, often swollen in upper part near ground level. The roots form vertical loops in sucker-generated plants. Leaves opposite or alternate and coriaceous, up to 35 cm long, tomentose on both sides when young, becoming glabrous above when fully grown. Flowering occurs during February – April.

6.1. Flower

Tendu plants bear 3 types of flowers i.e. pistillate, staminate and perfect, but sometimes dioecious situation do exists. Under such conditions, suitable pollinizers are needed. The male flower with non-functional ovary usually appears axillary in the clusters of 3-4 flowers. Male flowers are mauve in colour, tetramerous to sextamerous, 1-1.5 cm long, sessile or nearly sessile in short peduncles, mostly 3-flowered. Female flower can be easily distinguished by presence of four lobbed large dark green calyx. The flowers appear singly. Female flowers are mauve, mostly extra-axillary or sometimes solitary, axillary generally 2, opposite each other, larger than the male flowers. The hermaphrodite flowers are intermediate in size and occasionally found in the cluster of male flower.

6.2. Flowering

Flowering in tendu starts after 5-7 years of planting. In case of seedling plants under forest eco-system, flowering and fruiting get further delayed. The flowering takes place on new growth. In most of the case of tendu, flower bud differentiation starts in early June and continues up to August. The tendu plants inters into floriferous phase during spring. The flowers appear from April to June on new shoot and the fruits ripen after 1 year.

6.3. Fruit

Tendu fruit is a drupe which develops from superior ovary. Calyx remain attach with fruits which provides better attachment of fruits with branches. Fruits olive green, ovoid or globose 3-4 cm across; 1-, 2-, 3-, 4-, 5-, 6-, or 8-seeded berries. Pulp is yellow, soft and sweet. Seeds compressed, oblong, shiny, often banded. Some times tendu set fruit parthenocarpically. It has double sigmoidal growth pattern. During the fruit developments, dropping of unfertilized and insect damaged fruits become a severe problem which can be controlled by spray of GA₃ at full bloom stage. Fruits are available in the month of May and June. The tree produces good seed in alternate year.

7. Climate and Soil

It can be grown in wide variety of soil including laterite and black soil. Forests soil with high humus content support the plant growth and fruiting.

Under forest ecosystem, tendu plant grows in rocky soils as well. For commercial cultivation, soil with good water holding capacity and humus content are the best. It grows on poor denuded soils, hot and dry hill slopes, stony soils with quartzite, shale and sandstone, and also heavy clays. It can be grown in variety of soil including laterite and black soil. It however attains best growth and development on loose, porous soils in cool and moist sheltered valleys where it tends to be gregarious. Tendu is subtropical deciduous fruit plant available up to 0-900 m altitude, It can grown where mean annual temperature: 0-48 °C, mean annual rainfall: 500-1500 mm. Clear winter during November to February rest the plant and become dormant. With the increase in temperature during spring, new foliage and flower appear. High temperature and humidity is good for fruit development and ripening.

8. Propagation and root stock

Actually most of the tendu plants available in the forest are naturally regenerated through seedlings, coppice and root suckers. No systematic work on propagation of tendu has been taken up however artificial propagation is through either direct seeding or planting nursery-raised seedlings. It has recalcitrant seed which lose its viability within short period under normal temperature however, at freezing temperature (0°C) with 45-50 % moisture content, it can be stored for almost 18 months (Kotobuki, 1978). Stratification and priming of seed have been reported to be beneficial for germination and seedling growth in *Diospyros lotus* which is used as rootstock for most of the *Diospyros* species worldwide. Seed germination is not at all a problem in tendu but it takes more than 70-80 days to attain satisfactory germination. Enhancing the temperature help improves the seed germination.

Soaking seeds for about 12 hours in cold water improves germination. Stump planting has been found to be as good as direct seeding. The grafting and budding may be successful for vegetative regeneration. Owing to slow growth habit of plants, selection of appropriate rootstock and standardization of age and vigour of Tendu seedling for the purpose of grafting has a great importance. A mixture of FYM, soil and sand in the ratio of 5:3:2 improves the seed germination in the nursery bed and polythene bag. Germination can be accelerated by frequent irrigation and covering to bed with paddy straw.

Budding, grafting can be made during January-March on appropriate rootstock. Patch budding on 6-9 month old seedling can also be attempted to develop true-to-type tendu plant with varied level of success. Orthodox seed storage behaviour; viability maintained for 1 year in open storage; viability lost within 1 year in hermetic storage at room temperature with 11-15% mc. About 5 kg of ripe fruit yields 1 kg of seeds, weighing 1100-2000 seeds/kg.

9. Varieties and crop improvement

Tendu is a lesser known or underutilized fruit in India. Under National Mission on Plant Biodiversity, some promising germplasm of tendu have been collected from Jharkhand, West Bengal and Bihar and are being maintained at Horticulture and Agroforestry Research Programme, Ranchi (Anon, 2004). Under Jharkhand, wide range of variation with respect to fruit size, weight, fibre content in pulp and total soluble solids content in pulp has been noticed (Anon, 2004). The germplasm evaluation is under progress however, no variety has been developed and recommended for cultivation. There is great variability in taste from the wild mild astringent fruits at ripening and the other with sweet type. Tribal people also have preference of fruit size and therefore some local land races with better size and pulp content is also maintained in countryside. Arora and Pandey (1996) reported 12 species being found in different parts of India.

10. Cultivation

10.1. Planting

Tendu is a medium-sized tree or shrub in natural condition available in the forest where mostly degraded lands are available. In good type of soil like sandy loam soil plant takes the good shape and growth. It is therefore, essential to determine the spacing of plants as per the existing soil and climatic conditions. In eastern parts of the country particularly having laterite soil and rocky land, the spacing should be about 6 m apart. In Gangetic plain, a spacing of 8-10 m in square system can be opted for Tendu. The pit of 1m³ sizes are prepared during summer and filled with good soils and high humus content. The planting is done during July-August. Since, Tendu is a slow growing plant, more than one year old plant having well developed roots and at least few functional leaves should be planted. Prefer the planting in square system for easy orchard operation. At undulating topography under rainfed system, trenches of appropriate dimension are prepared for each plant on the upper side of plants for rain water harvesting and *in-situ* moisture conservation.

10.2. Training and Pruning

It is mainly grown for its leaves which have commercial value for bidi industries. The seedlings are normally planted at 2 m x 2 m where the objective of management is the production of leaves. Heavy pruning is recommended as this promotes vegetative growth and the production of relatively large and thin leaves, although repeated pruning can cause stunted growth of trees.

Plants up to 15 cm in girth are cut near the ground to encourage sprouting of coppice shoots, which gives best quality leaves after 40-50 days of operation. Coppicing experiments in India revealed that best quality of trade leaves are obtained by coppicing flush to the ground level twice, 2 weeks apart, then coppicing flush to the ground only once. The tree also pollards well, although the growth of the pollard shoots is slow. Pollarding is done to obtain a good flush of tender leaves, and plants over 15 cm girth are usually cut at 60-90 cm height. The quality of the leaves also depends on whether the frequency and intensity of pollarding impairs the vitality and growth of the trees. Management for small timber, poles or firewood requires a coppice rotation of about 30 years to give usable products. For ebony wood, a much longer rotation would be needed to give sufficient dimensions to the valuable heartwood. For the purpose of fruit, the plant is seldom pruned. No coppicing are allowed. Old plant having criss-cross and diseased branches should be pruned time to time for quality and quantity of fruits. However, training of plant is an essential operation for proper framed to the plant. Being slow growing plant, formation of scaffolds and branches take many years. The initial frame work process is completed within 3-4 years. After harvesting of fruits in bearing plants, stubs of previous season fruits are removed to facilitate new flush and fruiting terminals. The best time of pruning operation is summer after harvest of fruits.

10.3. Orchard Management

Systematic orchard management practices for Tendu have not been developed so far. For proper yield and good quality fruits, appropriate doses of nutrients as per requirement of site, proper irrigation, pest and disease management may be followed which need to be standardized.

10.3.1. Weed control

Some unwanted plants also grow along with crop plant. It competes with main crop for water, nutrient and solar radiation and even grows faster than the main crop and orchard look like a barren land.

Summer ploughing between rows is best method to control weed and hand hoeing is done under canopy.

10.3.2. Mulching

It controls weed and maintain soil moisture near root zone of plant. Mulch materials like paddy straw, saw dust, dry banana leaf, polythene etc. can be used. Black polythene is most suitable to control weed. Organic mulching improves soil structure as well as control weed and improve activity of beneficial micro organisms near root zone.

10.3.3. Intercropping

The results of regular cultivation of Tendu mixed with agricultural crops are not known. Its cultivation on field boundaries or distributed in field crops, such as oilseed and cereal crops, appears to be a feasible and attractive proposition. Its deep tap-rooting habit would minimize competition with annual crops. During initial stage of establishment, intercropping of legumes is advocated. Location-wise suitable legumes should be grown during rainy season. It restricted the weed population and improves the soil properties. Mulching of plants basin also check weeds near feeder root zone. In grown up orchards however, only shade loving crops can be grown in inter spaces during rainy season. If irrigation facilities are available suitable vegetables can be grown during leaf fall stage of Tendu plants.

10.3.4. Nutrient application

It is hardy and natural plant in tropical forest. No systematic work on nutritional aspect of the tree has been made. The newly transplanted developing plants can be supplied with complete fertilizer of 25-50 g N, 20-25 g P₂O₅ and 20-25 g K₂O per tree basis up to initial 3-5 years. When plant starts bearing, the doses should be enhanced by 2-3 times. Foliar application of Urea (0.1%) and micro nutrients have beneficial for growth and yield. High dose of phosphorus and humus containing of manures and fertilizers have been found beneficial for *Diospyros*.

10.3.5. Water Management

There is no systematic work on water management has been planned due to growing in forest area. The proper soil moisture practices like bunding, trenching and mulching may be showed good results in term of production of fruit. However, the proper soil moisture during period of fruit development is very much essential. For young developing plants, sufficient soil moisture in root zone helps improve the initial vigour and growth of plants. Tendu is deciduous plant which shed its leaves during dormancy hence conserves a lot of water. In bearing plants, irrigation during fruit development period improve fruit yield by reducing the fruit drop and enhancing the pulp content. Mulching of basins with locally available organic mulch during summers help to improve the efficiency of applied water and maintains uniform soil moisture near root zone.

10.3.6. Disease management¹

In general it is very hardy from biotic and abiotic stress. No disease and disorders found in this plant. Some times *Cercospora* leaf spot, circular leaf

spot and anthracnose cause foliar diseases. Crown gall at apex of twig and dematophora root rot at nursery stage also cause damage in Tendu. Leaf spots in Tendu are mainly caused due to high humidity and long rainy days coupled with high temperature. Older leaves are affected much with the disease. The disease can be controlled by timely spray of Bordeaux mixture, or by any Cu-fungicide, chlorothalonil or mancozeb. Blue mould (*Penicillium sp.*) is the major post harvest disease which initiates from the damaged portion of fruits during storage and transportation (Kitagawa and Glucina, 1984). The fungus *Stereum lobatum* causes white spongy rot in field timber.

10.3.7. Pest management

Various kind of bugs, flies, thrips and borer are found to infest tendu plant. Mealy bugs and pentatomid bugs are the major pests where as thrips and flies are of minor importance in *Diospyros sp.* (Kitagawa and Glucina, 1984). *Trioza obsoleta* feeds on the sap and forms rough reddish-yellow galls on the leaves. Among the defoliators are *Euthalia laudabilis*, *E. nais*, *Lamida carbonifera* and *Miresa albipunctata*. The larvae of *Plocaederus ferrugineus* bore between the bark and the sapwood. Various kinds of bugs, flies, thrips and borers are found to infest tendu plant causing damage.

11. Yield

There is wide variability in fruit size and availability. The yield of Tendu fruit depend on size of tree and intensity of fruit set. Under natural condition, a tendu plant produces 30-70 kg fruits every year depending upon age and soil and climate. About 5 kg of ripe fruit yield 1 kg of seeds, weighing 1100-2000 seeds/kg.

12. Harvesting and Post Harvest management

Tendu is a non climacteric fruit which ripen on trees itself. Due to thick sepals stem end, the ripe fruit remain attached with plant for quite long period. Therefore, harvesting of fruits should be done at right stage of maturity for market point. When the fruit turns yellow-orange in colour, it should be harvested. At the time of physiological maturity, the fruit peduncle develops abscission layer and separated easily from the main fruit stalk. The fruits are graded as per size, shape and blemishes on it. The misshapen and under sized fruits are sorted out before packing. Tendu can be packed in wooden baskets for local market. Lining of basket with green leaf help maintain better fruit texture and firmness during transportation. Tendu can be stored for 4-6 days at ambient temperature after full ripening. Therefore, for long distance market, fruit should be harvested at hard ripe stage.

13. Value addition

Tendu leaf is the second largest forest product in India after timber and is exclusively used in making local cigarette called Bidi. Annual production of tendu leaves is stable around 300,000 tones as reported by (Gupta and Guleria, 1982). Madhya Pradesh is the largest tendu producing state. Leaves obtained from a number of trees in India are used for wrapping a cheap type of cigarette, vernacularly known as 'bidi'. Amongst *Diospyros species*, the leaves obtained from *Diospyros melanoxylon*, vernacularly known as 'tendu', 'kendu', 'abnus' or 'bidi' are the most extensively collected both for local consumption and for export. Most of the tendu leaves in India are obtained from natural vegetation. The leaves collected from coppice shoots and root suckers are preferred for cigarette making, because they are generally larger, thinner and relatively more pliable with less prominent veins than those obtained from mature trees.

Development of value added product from Tendu has been attempted by Umesh *et al.* (2012) as tendu wine which was well acceptable among the consumers. Tendu fruits are seasonally available in South Asian countries like India in sufficient quantities during the summer months (May-June). The shelf-life period of the fruit is very less (<1 week). Tendu wine provides an avenue and scope to ferment these fruits into value-added products such as wine to preserve its nutrients, minerals, aroma and taste to the consumers round the year. It has also consumed as fresh, however, juice and jam can be prepared from pulpy varieties.

13.1. Other products

13.1.1. Food

The fruits and powdered seeds are sold in local markets and eaten.

13.1.2. Fodder

A tolerance to pruning makes *D. melanoxylon* a good fodder species. The leaves are reported to contain 7.12% crude protein, and 25.28% crude fibre.

13.1.3. Fuel

Tendu (*D. melanoxylon*) is reported to be good fuel wood; calorific value of sapwood is 4957 kcal/kg and of heartwood is 5030 kcal/kg.

13.1.4. Timber

Wood is hard, whitish-pink, tough, fairly durable and used for building, shoulder poles, mine props and shafts of carriages. The ebony is very heavy and valued for carving and other ornamental works.

13.1.5. Medicine

The seeds can be intoxicating; they have been prescribed in India as a cure for mental disorders, nervous breakdown and palpitation of the heart. Flowers are used in urinary and skin troubles, blood diseases, leucorrhoea, burinary discharge and anaemia and also as a diuretic. The fruits have a cooling and an astringent effect. Dried flowers are reportedly useful in urinary, skin and blood diseases. The bark is astringent; its decoction is used in diarrhea and diabetes (Jadhav et al., 2009). Stem bark is also used in treatment of dyspepsia, astringent (eye), dysentery, ulceration of cornea and post-natal pain Leaves are used as styptic, in the treatment of scabies and old wounds, and as laxative and carminative medicine. Fruits are used in stomach disorders (Lalita et al., 2002).

14. Future research thrust

Tendu is an underutilized and widely spread species for fruit. It is mainly known for bidi leaves for its commercial value. It is found as deciduous forest tree having wider adaptability under adverse soil and climatic conditions and tolerance against biotic and abiotic stress as a result it has a bright future in the country as a fruit. Due to high nutritional value and anti-oxidant properties of the fruits, it is imperative for making awareness among the common people for using it as a fruit. Need to pay attention on genetic conservation in in-situ and ex-situ. Development of high yielding dwarf variety will be helpful for its commercialization as an important fruit. Need to standardize propagation techniques and make availability of quality planting material in government nursery to meet the local demand. Incorporation of planting in different tree plantation project for integrated forestry-based cropping system is the present need. Development of package and practices with special reference to nutrition, water, control of fruit drop and diseases and pests are the need of hour in Tendu for higher fruit production. Standardization of value added products from tendu fruits should be emphasized.

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