

**Horticultural Crops
of
High Nutritive Values**

K.V. Peter

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Brillion Publishing

22 B/5 Ground Floor, Desh Bandhu Gupta Road,
Karol Bagh, New Delhi - 110005
Ph.: + 91 (11) 4155-8799
Email: info@brillionpublishing.com
brillionpublishing.com

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Rayan/Khirnis

A. Keerthika, Dipak Kumar Gupta,
M.B. Noor Mohamed, Vikas Khandelwal,
A. K. Shukla, B.L. Jangid and V. Subbulakshmi

The tree *Manilkara hexandra* (Roxb.) Dubard commonly known as Rayan/ Khirni is an important minor underutilized fruit tree belonging to the family Sapotaceae. It is believed to be originated in Indian subcontinent and is well adapted to semi-arid regions and tolerant to drought conditions. The tree bears attractive golden yellow fruit colour high in pulp content which is soft and sweet in taste with high nutritive value. These qualities make this fruit more important among tribal inhabitants and also provide substantial livelihood support to them. This fruit contributes in the nutritional security of the women and children by supplementing micronutrients and vitamin -A. Since ages, the tree is associated with rural folks for its ethno medicinal importance. Traditionally, plant parts have been used in medicinal herbal drugs to cure various diseases such as jaundice, fever, colic dyspepsia, arthritis, helminthiasis, hyper dyspepsia, tooth ache and dysentery. Apart from this, the tree is the most commercially used as rootstock for grafting of sapota plants.

1.1. Composition and uses

Tree is of multipurpose use. Fruit has nutritional value while other parts like leaves, seeds, bark, wood etc. provide several other benefits which have been discussed here.

Fruit

Manilkara hexandra (Roxb.) Dubard: Fruit is milky, sweet, sour, cooling, aphrodisiac, appetizer, emollient and tonic and a good source of minerals, sugars, protein, carbohydrates, vitamins-A and C as listed in Table 1. Fresh or dried fruits are sweet, consumed raw as well as after drying by local inhabitants/tribal people (Malik *et al.*, 2010 and 2012). Fruit serves as 'Vitamin A capsule' especially for nutritionally deficient tribal women and children. Mashed fruits are taken to cure diseases like arthritis, jaundice, heat burning, deworming, and for blood purification.

Table 1. Nutrient value of fruits per 100 gram

S.No	Nutrient content	Value
1.	Moisture	68.61
2.	Protein	0.48
3.	Carbohydrates	27.74
4.	Mineral matter	0.75%
5.	Fat	2.42
6.	Calcium	83mg
7.	Phosphorus	17mg
8.	Iron	0.92mg
9.	Carotene(Vitamin A)	675 IU
10.	Thiamine	70.33 µg
11.	Riboflavin	77.41 µg
12.	Nicotinic acid	0.66mg
13.	Ascorbic acid	15.67mg

(Anon, 1957)

Bark

Bark of tree is astringent, sweet, cooling, aphrodisiac, alexipharmic, stomachic/stimulates digestion and anthelmintic; traditionally used in wide range of gastro-intestinal disorders. Decoction of bark is used for treatment of dysentery and diarrhoea. The bark also contains 10 % tannin, used for treatment of fever and may be utilized in tanning purposes (Anonymous 1962). The bark retards the fermentation of toddy (traditional alcoholic beverage).

Wood

Wood is very hard, tough and durable and used for heavy structural work, gate posts, turnery, oil press and big beams. The tree also exudes gum. The latex of tree is applied on teeth for gum and tooth aches. Milky latex of the plant is used to treat on wound healing (Hitesh and Patel, 2015). The wood had calorific value of 4664 Kcal/kg.

Leaves

The leaves of *Manilkara hexandra* (Roxb.) Dubard have also good nutritive value and suitable for cattle feeding. It contains about 9.3% crude protein and 23% crude fibre (Table 2). In parts of Maharashtra, *Manilkara hexandra* (Roxb.) leaves are used as buffalo feed.

Table 2. Composition of Khirmi leaves on dry basis

S.No	Composition	Percent
1.	Crude protein	9.3
2.	Crude fibre	23.14
3.	Nitrogen free extract	53.9
4.	Ether extract	6.2
5.	Calcium	2
6.	Phosphorus	0.49
7.	Total ash	7.4

(Patel and Patel, 1957)

Seed

Manilkara hexandra (Roxb.) seed is also good source of edible oil. Generally seed contains about 24.6% oil on extraction with ether or petroleum ether, while, when pressed mechanically the yield is about 17.5%. The oil is demulcent and emollient, used for cooking purposes (Anjaria, 1997, Xian-zi, 1996). The chemical composition of the extracted oil is given in Tables 3 and 4. Oil is pale yellow in colour with an odour of reminiscent olive oil; after extraction of oil the seed cake contains a bitter saponin called sapogenin. Seed cake has low manurial value (Nitrogen -1.5% and Phosphorus-0.2%).

Table 3. Characteristics of pressed oil

S.No	Characteristics	Values
1	Specific gravity	0.92
2	Acid value	1.45
3	Saponification value	191.1
4	Iodine value	65.1
5	Acetone value	5.4

Table 4. Fatty acid composition of oil

S.No	Fatty acid composition	Values
1	Palmitic acid	18.9
2	Stearic acid	14.1
3	Lignoceric acid	1.1
4	Oleic acid	63.2
5	Linoleic acid	2.7

(Patel, 1940)

1.2. Origin and distribution

Manilkara hexandra is indigenous to Sri Lanka, Deccan Peninsula, Bengal, SE Asiatic mainland and Hainan, and cultivated throughout the Central India and Deccan Peninsula (Anonymous 1962; Hammer 2001). It is found in wild condition in dry evergreen forests and also in deciduous forests of Western and Central India, more commonly in the states of Rajasthan, Gujarat, Madhya Pradesh and Maharashtra (Malik *et al.* 2010). They are also located near Pritam Pura in Ratlam, Chanderi in Ashok Nagar districts, Neemach and Dhar districts of Madhya Pradesh, Panchmahal, Bharuch, Dahod and Sambarkanta districts of Gujarat; and Sirohi district of Rajasthan. Owing to its economic importance as fruit tree, this species is occasionally cultivated in backyards, home gardens, parks, farmers' fields and community lands.

1.3. Climate and soil

Manilkara hexandra (Roxb.) can withstand maximum temperature of 40 to 46°C and minimum of 0-14°C. The average rainfall is 620-1300 mm. It can be grown in different types of soils. Well drained loamy soils and medium black soils are suitable for cultivation. However, it is commonly grown in laterite and sandstone soils. It is suitable for sandy wastelands of semi-arid regions. Soil with hard rocky substratum and impervious clay are not suitable.

2. Improvement

2.1. Taxonomy

Khirni belongs to the order Ericales, genus *Manilkara* and family Sapotaceae. It is found in association with *Bassia latifolia* in natural forest. The chromosome number of *Manilkara hexandra* is $2n = 24$ (Mehra and Bawa, 1969).

Local names:

Syn. *Mimusops hexandra* Roxb.

- Sanskrit: Rajadana, Nimbabij
- Hindi: Driih, Khirni, Kshiri, Rayan
- English: Ceylon Iron Wood, milk tree, wedge-leaved ape flower
- Malayalam: Pazhamunpaala, Krini
- Bengal: khirkejur
- Kannada : Bakula
- Gujarat: Rayan
- Telugu : Pala, Manjipala, Puttapala
- Oriya: khiri, Khairakuli
- Tamil: Ulakkaippalai, palle, Palai, Kanupala, Karupala

Evergreen tree, 15-20 m tall, with blackish gray and deeply furrowed bark with conical degenerated branchlets; leaves elliptic, obovate or oblong, 7-10 cm long and 3.5-6.0 cm broad, apex obtuse or emarginated, Margin entire, glabrous, dark green, midrib more prominent beneath, petiole up to 2.5 cm long; flowers bisexual, white, in axillary fascicles of 2-6, pedicels stout, calyx 6-lobed, ciliolate, corolla 16 or 24-lobed in 2 or 3 series, outer ones linear, Inner ones oblanceolate, stamens 6, anthers acute, as long as the filaments, staminodes 6 or 8, alternate with the stamens, more or less denticulate and glabrous, ovary 12-celled and hairy; fruit Berry, shape ovoid, shining yellow and 1-seeded. Seeds are endospermic, oily with hard and glossy light brown to blackish seed coat.

2.2. Cultivars

There are no improved cultivars but locally grown trees show variation from tree to tree for characteristics viz., size, shape, colour, pulp content and taste of fruits. Germplasm accessions are collected and being evaluated at ICAR-CHES (Central Horticultural Research Station),

3.1. Seed propagation

Khirmi is generally propagated by seeds. Per kg of seeds counts approximately 8000 seeds. It exhibits problems of low seed germination and slow growth. Fruiting occurs during summer season (April - May) and lasts for 25-30 days. Seed possesses intermediate seed storage behaviour and longevity lasts up to 4 months. Freshly collected seeds have 37% moisture content and 86% germinability. Though they possess very short viability period, some of the studies have proved to enhance seed germination as listed in Table 6.

Table 6: Seed Treatments for Enhancing Germination (%)

S.No	Seed treatment	Duration (hrs)	Germination %	References
1.	Soaking in cow dung slurry	24	66.8& 78.7	Shirol <i>et al.</i> 2005& Patel <i>et al.</i> , 1996
2.	Cycoel solution at 200ppm and incubate at 40°C	24	65.3	Hiwale, 2015
3.	Incubate seeds at 35°C	12	55	Nikam <i>et al.</i> , 1986
4	Hot water at 40°C	24	45	Hiwale, 2015
5.	Ethephon 50 ppm at room temperature	24	54.6	Hiwale, 2015
6.	GA3 50 ppm	24	92.3	Wankhede <i>et al.</i> 2008

Use of fresh seed, soaked in water for 12- 18 hr or wrapping the seeds in wet sphagnum moss after treatment with fungicide for 4-6 days resulted in faster and better germination. They are sown in raised seed beds or pots. The seeds germinate in about 4 weeks. GA 300ppm sprayed on seedlings increased its height up to 85.3 % (Anonymous, 1982). Seedlings can be transplanted at four leaf stage or when they are about 15cm high. Raja *et al.*, (2001) reported that soaking seeds in thiourea at 1% conc. resulted in early germination (14 days) and enhanced germination (85%). Panchal *et al.* 2014 conducted experiment with different growing media viz., combination of soil+ coco peat + FYM (1:1:1)+ IBA 1000 ppm and found to perform better in terms of growth rate.

Godhra, Gujarat and ICAR-CISH (Central Institute of Subtropical Horticulture), Lucknow, Uttar Pradesh as mentioned in Table 5. Moreover, diverse accessions collected from parts of Madhya Pradesh, Gujarat and Rajasthan are recorded in ICAR-NBPGR (National Bureau of Plant Genetic Resources) data base and characterization study has been done. A wide range of variation was observed in fruit and seed characters which show prevalence of variability in natural populations (Malik *et al.* 2012).

Table 5: Germplasm accessions assembled in different institutes

S.No	Germplasm accessions	Location	Characterization	Conser- vation	References
1.	30	ICAR- CIAH Regional Station, CHES, Godhra	Promising genotypes - CHESK-1, CHESK -11 and CHESK -10	Field gene bank	http://www.ciah.ernet.in/germplasm_developed.php Sanjay Singh and Singh, 2015
2.	99	ICAR- NBPGR, Delhi	Morphological characterization has been done for 47 accessions. 23 accessions genetically evaluated using RAPD markers revealing 78% polymorphism	Cryo gene bank	Malik <i>et al.</i> 2012
3.	28	ICAR- CISH, Lucknow	To identify accessions having bold fruits with low seed content.	Field gene bank	Annual report, 2009-2010 (CISH)

3. Plant propagation

Manilkara hexandra is commonly propagated by seeds. Since it serves as rootstock for grafting of sapota plants, some of the studies have been conducted to enhance seed germination. Under natural conditions, the tree requires light *i.e* light demander and so regeneration does not take place under dense canopy. Very a few wildings are found in natural populations. Sometimes these wildings are also used as root stock for vegetative propagation of sapota. Vegetative propagation methods in khirmi are not common. However, a few works have been done to develop and standardize propagation technologies, reported here.

Vegetative propagation

Vegetative propagation methods are not much successful; still some of the studies have been attempted. Khirni can be propagated by air layering. Maximum rooting percentage (76) were obtained using growth regulator IBA with 5000 mg/l (Gowda *et al.*, 2006). Softwood grafting and veneer grafting have also been attempted with 75 % success (Singh and Ravishankar 2010; Malik *et al.* 2010). The highest percentage of softwood graft success was noticed in the month of March with 76% success followed by June, July and August which may be appropriate time for grafting in arid western India. Bud grafting is being attempted in Gujarat private nurseries for mass multiplication.

3.2. Micropropagation

In-vitro cryopreservation method, mainly using MS medium has been standardized by ICAR-National Bureau of Plant Genetic Resources, New Delhi.

4. Agro techniques

4.1. Planting

The seedlings are raised in polythene bags during rainy season. Two to three years old seedlings are suitable for transplanting in field. Planting is done at a distance of 8x8m. Pits of 1m³ size are dug and filled with Farm Yard manure (20-30) kg. Half kg of DAP should also be mixed with Farm Yard Manure.

4.2. Manure and Fertilizers

Well rotten Farm Yard Manure of about 20 kg should be applied per plant per year. For trees in bearing, FYM dose is increased from 50 to 80 kg depending upon the size and age of the tree. This is sufficient for growth, flowering and fruiting. In trees possessing luxuriant growth, manuring should be avoided. The application of 500g nitrogen, 300 g phosphorus and 250g potash per plant to the bearing trees after flowering favour good yield (Sen, 2004).

4.3. Irrigation

Irrigation should be given in initial stage and also during period of droughts. Water harvesting practices and conservation of soil and water measures should be adopted which are essential during critical periods.

4.4. Flowering, Pollination and fruiting

The tree flowers from November to January and the fruit ripens from April – July. Khirni is cross pollinated and mode of pollination generally by insects. There are very limited studies regarding pollination and fertilization. However, there is a reported study on blossom biology of *Manilkara hexandra* by Dwivedi and Bajpai (1974) in which 40% of pollination and 10% following natural pollination, 20% following hand pollination and 10% following selfing during November – December. Fruits were visible 12-17 days after pollination and took 110 days to mature.

5. Harvesting and yield

Ripening of fruit starts from April – July but the peak harvest is during the month of May. Fruits are harvested when they turn golden yellow colour; the mode of harvest is hand plucked from tree by tribal people. A full grown matured tree can give 1-2 quintals of fruit every year.

6. Post-harvest technology

There is no value added technologies or any processing facilities. Fruit is highly perishable in nature. Fruits may also be dried in sunlight to avoid deterioration and infection. The dried fruits are consumed during winter season. Tribal people use fruits for own consumption.

7. Income

In tribal areas of Western and Central India, people sell the fresh well as dried fruits in the local market at the rate of Rs. 30-40 per tree. Each tree provides fruits worth of Rs. 500-2,000. Fruits collected from trees have to be consumed or marketed within 24 hrs. Sometimes, fruits are transported to Mumbai and other nearby cities that fetch an attractive price.

8. Plant protection

Insect, Pest and diseases

There is no report on occurrence of any major pests and diseases. However, the gelechiids *viz.*, *Anarsia anthrionia*, *Acrocercops gemontella*, thyruid *Banisiomyia alislaralis*, the pseudococcids *viz.*, *Ferrisia virgata* *sp.* and the eriophyid *Aceria sp.* were reported in *Manilkara hexandra* nurseries in Gujarat, India, during October 1984-March 1985 (Jhala, 1985).

9. Conservation

Khirmi is presently found in natural populations. Due to heterozygous and cross pollinated nature, there is existence of high amount of variability. Trees found in wild populations are very old. There is need to conserve these population either by *in-situ* and *ex-situ* efforts. Successful cryo-preservation efforts have been developed for seed and embryo of Khirmi and have been stored as base collections for 60 accessions in ICAR-NBPGR. For *in-situ* conservation, the identified important variability pockets should be conserved by local tribal populations. As there is no organized cultivation and land is being cleared for agriculture, there is severe pressure on natural wild populations of Khirmi for its fruit by the tribal people. As a result, the species falls under the 'critically endangered' category. Popularization of this species is required to generate awareness for its cultivation and conservation, as it is important for tribal populations and for ecosystem diversity.

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