

CHES/KVK Technical Bulletin-1  
**JACKFRUIT... A VERSATILE FRUIT**

**ICAR-INDIAN INSTITUTE OF HORTICULTURAL RESEARCH  
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**Technical Bulletin on**  
Jackfruit.... A Versatile Fruit  
CHES, Hirehalli, Tumakuru, Karnataka

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**Foreword**

Jackfruit is native to parts of South and Southeast Asia and is believed to have originated in the rainforests of Western ghats of India and is cultivated throughout the low lands in south and southeast Asia. Jackfruit is the national fruit of Bangladesh and is one of the auspicious fruits of south India along with mango and banana. The jackfruit is a multi-purpose species providing food, timber, fuel, fodder, and medicinal and industrial products. The primary economic product of jackfruit is the fruit which is used both when mature and immature. It is a nutritious fruit rich in carbohydrates, proteins, potassium, calcium, iron, and vitamin A, B, and C. Due to high levels of carbohydrates; jackfruit supplements other staple foods in times of scarcity in some regions. The flesh of the jackfruit is starchy and fibrous, and is a source of dietary fiber. In spite of such a vast potential and usefulness, jackfruit remains an underutilized fruit species and deserves to be given the needed thrust for research and development. This technical bulletin publication entitled “Jackfruit ... A Versatile Fruit’ is an over view of Jackfruit where in attempt has been made to draw the attention of farmers, researchers and policy makers to show case the potential of this crop and get benefited fully in the years to come. I am confident that this compilation would be useful to growers and extension workers.

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Director,

ICAR-IIHR, Bengaluru

Place: Bengaluru

Date: 24th June 2015



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## JACKFRUIT... A VERSATILE FRUIT

### Introduction

Jackfruit (*Artocarpus heterophyllus*) is one of the most important fruit crops versatile and useful tree in tropical home gardens from the genus *Artocarpus*. It is a medium-size evergreen tree reaching approximately 8 - 25 m (26 - 82 ft) in height, that is easily recognized by its typical largest fruit among the cultivated plants. The succulent, aromatic, and flavourful fruit is eaten fresh or preserved in many ways. The nutritious seeds are boiled or roasted and eaten like chestnuts, added to flour for baking, or cooked in dishes. It is also known for its durable timber, which on aging changes to an orange or red-brown colour. The leaves and fruit waste provide valuable feed for cattle, pigs, and goats. Many parts of the plant including the bark, roots, leaves, and fruit are attributed with medicinal properties. Wood chips yield a dye which is used to give the famous orange-red colour to the robes of Buddhist priests. The tree can provide many environmental services. It is highly wind tolerant and thus makes a good component in social forestry as a windbreak or border planting. In home gardens, the dense jackfruit canopy can provide a visual screen and is very much ornamental. Introduced to most of the Indian states, the tree can be found throughout the country, mainly in home gardens, where it finds a place among other favourite multipurpose plants. It is easy to grow and more adaptable than some of the other common *Artocarpus* species such as breadfruit (*A. altilis*).



## *Nutritional properties*

Jack fruit is rich in several nutrients. It has vitamin B, C, potassium, calcium, iron, carbohydrates and proteins at high level. Its seeds are rich in proteins and can be used as delicious nut. The chemical composition of the fruit (ripe and tender) and seeds are detailed below:

### **Nutritional value per 100 g edible portion**

<b>Constitution</b>	<b>Seeds</b>	<b>Ripe fruit</b>	<b>Tender fruit</b>
Carbohydrates (g)	25.6	19.6	9.3
Moisture(%)	64.4	76.1	83.0
Fat (g)	0.4	0.1	0.3
Fibre (g)	1.5	1.2	2.7
Protein(g)	6.5	1.7	2.5
Total mineral matter	1.2	0.9	0.9
Potassium(mg)	-	-	26.2
Calcium(mg)	50.0	20.0	30.2
Phosphorous (mg)	96	41.1	40.2
Iron (mg)	1.6	0.55	1.6
Energy (K cal)	132.0	87.0	51.3
β Carotene (mg)	-	174.0	-
Thiamine (mg)	-	0.04	0.04
Vitamin C (mg)	-	7.1	13.0
Riboflavin (mg)	-	0.12	0.03

(Source: Practical manual No.10, International centre for underutilized crops, Srilanka)



## *Distribution*

The tree is reportedly native to the rainforests of Malaysia and the Western Ghats of India. Jackfruit has been cultivated since prehistoric times and has naturalized in many parts of the tropics, particularly in Southeast Asia, where it is today an important crop of India, Burma, China, Sri Lanka, Malaysia, Indonesia, Thailand, and the Philippines. It is also grown in parts of Africa, Brazil, Suriname, The Caribbean, Florida, and Australia.

## *Size and form*

Jackfruit is a medium-size evergreen tree that typically attains a height of 8–25 m (26–82 ft) and a stem diameter of 30–80 cm (12–32 in). The canopy shape is usually conical or pyramidal in young trees and becomes spreading and domed in older trees. The canopy diameter at 5 years old ranges from 3.5–6.7 m (11–22 ft) and can reach 10 m or more in older trees. The tree casts a very dense shade. Heavy side branching usually begins near the ground. All parts of the tree exude a sticky white latex when injured.

## *Flowers*

This species is monoecious, having male and female inflorescences (or “spikes”) on the same tree. Male and female spikes are borne separately on short, stout stems



that sprout from older branches and the trunk. Male spikes are found on younger branches above female spikes. Male spikes are dense, fleshy, cylindrical to club-shaped, and up to 10 cm (4 in) in length. Flowers are tiny, pale green when young, turning darker with age. Female flowers are larger, elliptic or rounded, with a tubular calyx. The flowers are found to be pollinated by insects and wind, with a high percentage of cross-pollination.

### *Leaves*

Leaves are dark green, alternate, entire, simple, glossy, leathery, stiff, large (up to 16 cm in length), and elliptic to oval in form. Leaves are often deeply lobed when juvenile and on young shoots.

### *Fruit*

Jackfruit has a compound or multiple fruit (syncarp) with a green to yellow-brown exterior rind that is composed of hexagonal, bluntly conical carpel apices that cover a thick, rubbery, whitish to yellowish wall. The acid to sweetish (when ripe) banana-flavoured flesh (aril) surrounds each seed. The heavy fruit is held together by a central fibrous core. Fruits are oblong-cylindric in shape, typically 30–40 cm (12–16 in) in length but sometimes up to 90 cm (35 in). They usually weigh 4.5–30 kg (10–66 lb), although a



weight of 50 kg (110 lb) has been reported. The heavy fruit is borne primarily on the trunk and interior part of main branches. Fruits take 90–180 days to reach maturity.

### *Seeds*

Seeds are light brown to brown, rounded, 2–3 cm (0.8–1.2 in) in length, 1–1.5 cm (0.4–0.6 in) in diameter, and enclosed in a thin, whitish membrane. Up to 500 seeds can be found in each fruit. Seeds are recalcitrant and can be stored for a longer period in cool, dry conditions and with proper storage.

### *Rooting habit*

Jackfruit has a strong taproot.

### *Similar species*

Champedak (*Artocarpus integer* [Thunb.] Merr.) is easily mistaken for jackfruit. There are several indicators differentiating the two species; perhaps the easiest to see is that champedak has smaller, rounder fruits, with less latex and thicker rind. However, champedak is rarely found in the Pacific.



## GENETICS

### *Variability of species*

As the flowers are open-pollinated, variation is exhibited in a wide range of characteristics such as tree size and structure, leaf and fruit form, age to bearing, and fruit quality. Fruit size, shape, and colour of the fruit and texture, odour, and taste of the edible pulp vary tremendously. An exception is the ‘Singapore’ (or ‘Ceylon’) cultivar, which bears comparatively quickly from seed—usually in 18–30 months—and is relatively true to type. It has medium-size fruits (6–12 kg) with soft, fibrous, and very sweet flesh.

### *Variability of varieties*

Commercially, grafted cultivars are normally planted. The fruit of most cultivars weighs 10–30 kg, although the full range of known cultivars is 2–36 kg and even heavier. The fruit is generally grouped into two major types by fruit quality: 1) thin, fibrous, and mushy edible pulp, usually very sweet and emitting a strong odour, and 2) thick, firm, often crisp, less fragrant pulp. There are numerous cultivars of each type in regions where jackfruit is a significant food crop, including South India, Thailand, Malaysia, the Philippines, and Ceylon.



### *Culturally important related species in the genus*

Jackfruit belongs to the genus *Artocarpus*, a genus rich in culturally important species including breadfruit (*A. altilis*), dugdug (*A. mariannensis*), and breadnut (*A. camansi*). These three species represent some of the most important traditional subsistence trees of Pacific islands. Elsewhere in Southeast Asia and India, champedak (*A. integer*), lakoocha (*A. lakoocha*), marang (*A. odoratissima*), kwai muk (*A. lingnanensis*), and others are important fruit trees, all with culturally important uses, and many with other valuable products, such as timber.



## USES

The Jack is considered as Kalpavruksha in the Indian sub continent. It is a multipurpose tree species. It provides food, fuel, timber and medicinal extracts, and is a potential source of income for both the rural and urban people of the tropics and subtropics. It assumes the role of a secondary staple in certain areas that are particularly prone to variable climatic conditions which lead to food shortage. The different uses of the jackfruit tree are summarized below

### *Staple food*

The pulp of the young fruit is cooked as a starchy food and has a consistency resembling meat. The young fruit is also pickled or canned in brine or curry. The ripe fruit is eaten fresh or is processed into numerous delicacies including jam, jelly, and chutney. It also makes an excellent dried fruit or preserved candy when combined with sugar or honey. The pulp is also used as a flavouring in ice cream and drinks.

### *Nut / Seed*

The seeds must be cooked by boiling or roasting prior to eating. They are an excellent addition to curries, or can be eaten freshly cooked or dried with salt as a snack. The cooked and dried seeds are milled to a flour-like consistency and added to bread dough.



### *Leaf and other vegetable*

The tender young leaves are cooked and eaten as a vegetable. Young male flower spikes can be grated or smashed and eaten with salt and vinegar as a vegetable, or pickled. They are also cooked and served as a vegetable.

### *Beverages*

Besides using for flavouring beverages, the fruit can be fermented and distilled to produce an alcoholic liquor.

### *Medicinal properties*

Parts of jackfruit trees are used in traditional medicine throughout tropical Asia. However, no major clinical evidence is available to support these uses.

### *Roots*

An extract of roots is used in treating skin diseases, asthma and diarrhoea.

### *Leaves*

An extract from leaves and latex treats asthma, prevents ringworm infestation, and heals cracking of the feet. An infusion of mature leaves and bark is used to treat diabetes and gall stones. A tea made with dried and powdered leaves is taken to relieve asthma. Heated leaves can treat wounds, abscesses and ear problems, and relieve pain.



### ***Bark***

An extract from bark or rags (the non-edible portion of ripe fruits) or roots is used in the treatment of dysentery and release of the placenta after calving in cows. Ashes produced by burning bark can treat abscesses and ear problems. Extract from seeds or bark helps digestion.

### ***Inflorescence and fruits***

Crushed inflorescence is used to reduce bleeding in open wounds. Ripe fruits can be used as a laxative.

### ***Seeds***

Extract from freshly extracted seeds is used to treat diarrhoea and dysentery.

### ***Flavouring / Spice***

The ripe pulp, fresh, concentrated, or powdered, is made into flavouring for ice cream and beverages.

### ***Masticant / Stimulant***

The latex can be used as chewing gum.

### ***Timber***

The wood is classified as a medium hardwood (specific gravity 0.6–0.7) and is highly valued for building material, furniture and cabinet making, and even for musical



instruments. It is highly durable, resisting termites and decay, seasoning is easy, resembles mahogany in appearance, and takes a beautiful polish. As the wood ages, it turns from yellow or orange to red or brown. Although not as strong as teak (*Tectona grandis*), jackfruit wood is considered superior for many purposes including furniture, construction, turnery, masts, oars, implements, and musical instruments. The excavated roots of old trees are highly prized for carving and picture frames. Damaged trunks/branches are used as firewood.

### ***Wrapping***

In India, leaves are used to wrap food for cooking and are woven together and used as plates.

### ***Resin / Gum / Glue / Latex***

The heated latex can be used as a glue for mending chinaware and pottery and as caulking for boats and buckets. The latex contains resins that has use in varnishes. The latex also has bacteriolytic value comparable to that of papaya latex. Additionally, the sticky latex is used for trapping birds (birdlime) and for insect traps.

### ***Tannin / Dye***

Bark contain 3.3 per cent tannin. When boiled with alum, wood chips, or sawdust, it yields a dye that is commonly used to give the characteristic colour to the robes of Buddhist priests and in dying silk.





## GROWTH AND DEVELOPMENT

Jackfruit is a rapid grower, reaching a height of 3 m (10 ft) and canopy diameter of 2 m (6.6 ft) in 2 years. Apical growth for the first few years is about 1.5 m/yr (5 ft/yr), slowing to 36–60 cm/yr (14–18 in/yr). A 20-year-old tree can reach 17.5 m (57 ft) in height and 20 cm (8 in) in trunk diameter. Jackfruit seedlings grow slowly in heavy shade. Weeding is recommended to lessen competition for light, water, and nutrients. While trees can live up to 100 years of age, significant decrease in productivity with age has been reported after 20 years of growth.

### *Flowering and fruiting*

This species is monoecious, having male and female inflorescences (or “spikes”) on the same tree. Male and female spikes are borne separately on short, stout stems that sprout from older branches and the trunk. Fruits of most of the cultivars reach maturity in middle to late summer. In Asia, depending on the climatic region, fruits ripen mainly from March to June, April to September, or June to August, with some offseason crops from September to December.

### *Propagation*

Jackfruit seedlings are very easy to grow but usually take



4–14 years for bearing fruits, except few varieties such as ‘Singapore’ (or ‘Ceylon’) cultivar which starts bearing fruit within 18–30 months after transplanting. Seedlings develop very quickly, reaching 25 cm (10 in) in height within 3–4 months. Seeds are cross-pollinated and therefore not true-to-type, so grafting of known varieties onto rootstocks is often done, especially for commercial production where a uniform product with the best market qualities is important. As the seeds are large and grow quickly and their root systems are sensitive to damage during transplanting, direct-seeding in the field can give the best results. Field sown seedlings can be top-worked (grafted) with selected varieties once they are established. Propagation by vegetative means such as cuttings and air-layering is also possible, although uncommon.

### *Seed collection*

Trees usually bear fruit in two main seasons, although offseason fruiting is common. Collect seeds from fruits of trees with outstanding growth consistent higher yield and fruit qualities.

### *Seed processing*

After cut opening the fruit, seeds are separated from the fleshy sheaths that enclose the seeds. Each fruit contains approximately 100–500 seeds but there is no correlation between fruit size and the number of seeds it contains.



There are about 50–90 seeds/kg. The thin, slimy coating around the seed (perianth lobe) should be removed and the seeds thoroughly rinsed in water to remove any remaining pulp juice or sugary residue. Only the largest seeds should be used, as these will give the earliest and highest germination and produce the strongest seedlings. Seeds may be air-dried in the shade for about an hour for ease of handling, but they should not be allowed to dry out, as this will kill them. Germination of seeds sown within a few days of harvesting is usually high, around 90 per cent.

### *Seed storage*

Seeds are recalcitrant, i.e., they do not retain viability when dried or stored for extended periods. They should be planted immediately for best germination and seedling vigour. Seeds can be stored moist in a plastic container in the refrigerator for up to a few weeks. Stored seeds germinate more slowly than fresh seeds.

### *Seed pre-treatment and sowing*

Generally, no pre-treatment is required. However, soaking in water or a dilute gibberellic acid solution for 24 hours prior to sowing hastens germination and is recommended. Hot water treatment has been used successfully to stimulate germination. Seeds can be directly sown or can be raised



as nursery in the polythene bags. A well drained medium is recommended, such as 50 per cent peat moss, 25 per cent perlite, 25 per cent vermiculite amended with a little compost, dolomite lime, gypsum, and a 14-14-14 slow-release inorganic or an organic fertilizer.

### *Nursery*

In the nursery, 2–4 qt root-training containers work well. The seedlings should not be allowed to root through the container into the underlying substrate, as the roots would have to be cut or broken for transplanting. Seeds are sown at a depth of 2 cm (0.8 in), and can be laid flat or planted with the hilum pointing down.

### *Germination*

Normally, germination begins in 1–3 weeks, or longer (up to 6 weeks) if seeds were stored more than a few days after collection. Daily watering is often necessary once seeds germinate.

### *Transplanting*

Seedlings are transplanted when its size is approximately 20cm in height with a stem diameter of 9 mm (0.35 in). This takes about 3–4 months in good growing conditions. If seedlings are grown in the nursery, it is crucial to plant them before they become root-bound. Transplanting



seedlings when they have just filled out their growing container will ensure minimal trauma to the root system. In ideal conditions, field survival of about 90 per cent can be expected.

### *Direct-seeding*

Direct-seeding in the field is the best propagation method if the planting locations are well prepared, weed free, and frequently tended for the first 6–12 months of growth. It eliminates any transplant trauma. In direct-seeding, an area is prepared for each planting spot, cleared of weeds, and cultivated to a depth of 50 cm (20 in) if the soil is compacted. Seeds are planted at a depth of 2–3 cm (0.8–1.2 in). Sowing several seeds at each site allows for selecting the most vigorous seedling and can prevent the necessity of reseeding. The drawbacks of direct-seeding include risk of predator damage (e.g., rats, pigs, cattle, etc.), lack of rains to sustain the newly germinated seeds, and the mandatory frequent maintenance that must be done to ensure weeds do not overcome the seedlings.



## CULTIVATION

### *Climate and soil requirements*

Jack grows well and gives good yield in warm humid climate of hill slopes and hot humid climate of plains. The crop grows successfully from sea level upto an elevation of 1200 m at an optimum temperature range of 22-35°C. It cannot tolerate frost or drought. The yield and quality of fruits are medium under low humidity. The West coast plains with high humidity are found to be highly suitable. A deep rich alluvial or open textured loamy soil or red laterite soils with slightly acidic condition (pH 6.0 – 6.5) with good drainage is ideal for jack fruit; however, it can come up in variety of soils.

### *Varieties*

Cultivated or naturally found jack trees can be broadly classified into two types viz., firm flesh (*kappa*) and soft flesh (*rassal*) based on the firmness of the bulb. However, there are few important varieties introduced by and released from various organisations. A brief description of the same is given under the chapter varietal wealth of Jack.

### *Propagation and planting*

When propagated through seeds, jack exhibits a wide variation among its progenies. Hence vegetative propagation is recommended. Seedlings take around 7-8 years normally



for fruiting, whereas the grafts come to bearing within 4 ½ -5 years. Commercially, inarching on 10 months old jack seedlings is done to produce vegetative progenies. Soft wood grafting (cleft method) on 2 months old seedlings with scion of 3-4 months old also was found to be successful (70 - 80 per cent). Since the viability of seeds is very low, seeds have to be sown immediately after extraction to raise rootstocks. Rudrakshi and *A. hirsuta* are also used as rootstock.

Pits of size 1 cubic meter are dug at a spacing of 6-8 m and filled with top soil mixed with 10 kg farm yard manure. The grafts are planted in the centre of the pits during June-September. Proper staking has to be given to avoid lodging and subsequent breakage at the graft joint. Providing shade with coconut leaves and thorough mulching of basins after the cessation of monsoon season are essential to avoid mortality of grafts.

### ***Training and manuring***

Jack trees are trained to a single stem, side branches should be removed at its early stages so that a uniform smooth trunk develops for a height of 1.5 – 2 m and then side branches should be allowed to arise. The flower buds appear on trunk which should be kept free of vegetative growth. The nutrients should be applied as detailed below



### **Requirement of manures and fertilizers**

Manure/ Nutrients	1 <sup>st</sup> year after planting (kg/plant)	Annual increase (kg/plant)	5 <sup>th</sup> year on wards (kg/plant)
FYM	10	10	50
N	0.150	0.150	0.750
P	0.080	0.080	0.400
K	0.100	0.100	0.500

(Source: Technical Bulletin No.41 of ICAR- Research Complex,GOA)

The fertilizers are applied during rainy season taking advantage of optimum moisture. If irrigation is available they can be split into two doses and applied twice in a year i.e., during June –July and September – October. The manures and fertilizers can be applied in a circular trench of 30cm width taken 50-60 cm away from the trunk.

### ***Irrigation***

Though jack is cultivated under rainfed conditions, it is very sensitive to drought. Hence irrigation can be given depending on the type of soil, season etc., so that, there should not be any moisture stress especially during flowering and fruit set. Similarly too much of soil moisture will affect the quality of fruit. The carpels will develop an insipid taste when there is excess soil moisture.



### *Inter-cultivation*

During the pre-bearing age, pulses can be grown as intercrop. Dried leaves can be spread below the trees to serve as mulch for moisture conservation. As the trunk increases in size, the active buds of female inflorescence develop from the trunk as well as from main scaffold branches, this type of bearing habit is called 'cauliflorus'. These fruit buds should be protected from any possible damage by rubbing of body of the stray cattle such as buffaloes through spreading dried thorny bushes. This is very essential especially when there is no proper fence in the fields.

### *Plant protection*

In nature, Jack is a hardy crop which is not generally affected by major pests and diseases. However, the plants are seemed to have affected by the following pests and diseases, which may result in partial and total yield loss if not taken care of. Details have been given under the chapter

- a) Insect pests management.
- b) Diseases management.

### *Harvesting and yield*

Normally Jack starts producing fruits from 7th - 8th year onwards. Grafted plants start to yield from 4th - 5th year itself. In Singapore jack, even seedlings start bearing from



3rd year. The tree attains its peak bearing stage in about 15-16 years of planting. At this stage normally a tree bears up to 250 fruits annually with year to year fluctuation in yield. In India, 150 large fruits per tree annually is considered to be a good yield. The weight of fruits also varies depending on the type. On an average about 40-50 tonnes of fruits/ha could be obtained. The optimum stage of harvest of jackfruit has been reported to be 90-110 days after the appearance of the spike. Harvesting is done by cutting off the fruit stalks carrying the fruits. Normally the fruits will be available from March to June. In higher elevation harvest extends up to September. Even in plains certain genotypes bear an off season crop during October - December.



## VARIETAL WEALTH

Jackfruit has several types (or) forms with regard to their fruit characteristics. The types differ widely among themselves in bearing, density of spines on the rind, size, shape, quality and period of maturity. There is also a wide variation in its sweetness, acidity, flavour and taste. As Jack trees are propagated mainly through seeds and also they are highly cross pollinated, the existing types are highly variable due to its heterozygous nature.

An ideal jack variety should be,

1. Compact, short trees with more number of branches
2. Early in bearing
3. Big-sized fruits (10-15 kg) with attractive yellow skin
4. Tree capable of producing 50 per cent of yield in the regular season (April-June) and 50 per cent in the off season (October-December)
5. A fruit production potentiality of 150 per tree per year(1500kg) and high recovery of carpels from fruits
6. Bigger carpels (above 50 gm) with attractive golden yellow, orange colour, very tasty, juicy and fibreless.

### 1. Variability

Development of high yielding varieties of crops require information about the nature and magnitude of variability



present in the available stock and the selection depends upon a judicious assessment of the available data on phenotypic characters that are connected with yield. Being a highly cross pollinated crop and the method of propagation earlier reported is of seedling nature, considerable variability exists in the local jack plantations.

The leaves varied in length from 5.0 to 25.0 cm and in width from 3.5 to 12.0 cm. The shape varied from obovate-elliptic. Apart from the leaf area, other leaf traits like leaf blade shape, leaf apex shape and leaf base shape also exhibited considerable variations, further highlighting the role of heterogeneous nature of the seedling population owing to cross pollinated nature of jack trees. These leaf traits might be probably useful to identify ideal trees from the rest of the seedling trees or from the clonal materials.

Local jackfruits are classified into two groups, one with firm flesh and the other with soft flesh. The mature pericarp of this group is comparatively smaller in size. The juice is either thin or thick; colour varies from pale yellow to dark or golden yellow. Pulp is generally mushy or soft and of varying quality ranging from sweet to insipid. The seeds are comparatively larger. In the hard pulp group the pulp is crisp and highly flavoured and therefore relished. The juice is scanty and the seeds are comparatively smaller.



Local selections are named as ‘Gulabi’ (rose scented), ‘Champa’ (flavour like that of Champak), ‘Hazari’ (bearing large number of fruits). ‘Rudrakshi’ has common pummelo-sized fruits with smooth rind and less spines, whereas Singapore or Ceylon jack introduced from Ceylon, is highly precocious. Sometimes it produces light off-season crop between September and December. Muttam Varikka is another important variety producing fruits of 7 kg each and flakes of 3.6 kg.

A lot of variability occurs in evergreen forests of the Western Ghats, Gorakhpur, Dewaria (40 kg-sized fruits) and Allahabad (small with white, juicy and soft pulp) districts of Uttar Pradesh. Some of these types produce small to medium sized fruits with small seeds and thin skin, offering a great potential for the varietal improvement. The selections, namely, NJT1, NJT2, NJT3 and NJT4 with large fruits and excellent pulp quality have been identified for table purpose, while types like NJCI, NJC2, NJC3 and NJC4, have small to medium sized fruit with thin rind were found to be better for culinary purpose.

In South India (Kerala, Tamil Nadu and Karnataka), different forms of jackfruit (Varikka, Koozha, Navarikka) are available and the maximum diversity has been reported from Wynad Plateau of Western Ghats of Kerala. In Sikkim the varieties



like Soft Flesh, Firm Flesh, Rudrakshi and Singapore etc. are also cultivated. Further, less gum type identified at IIHR also has great potential for commercial acceptability.

In Karnataka so much attention is being given to this fruit in the recent times. The University of Agricultural Sciences, Bengaluru, Karnataka (India), released a jackfruit variety called Swarna in the year 2010. It is a very good yielder, bears fruits in bunches on the trunk, primary branches and also on the secondary branches. The medium sized fruits weigh 6-8 kg each. The fruitlets are golden brown in colour, juicy with a TSS of 25-26° Brix, with thick flakes and a very thin rind (<1.0 cm). Ten trees of this variety were planted at the university premises.

**Gumless Type :** The gumless type developed at the Indian Institute of Horticultural Research (IIHR), Bengaluru, India has medium to low latex with medium fruits (6.4-9.0 kg) having oblong fruit shape containing 120-140 flakes/fruit with Varietal Improvement

### ***Red fleshed Jack... (The consumers choice in Karnataka)***

In the recent time the red fleshed varieties are gaining importance among the consumers. As compared to red flesh pulp, the yellow pulp colour types tastes excellent. It has high aroma and higher sugar content. They are also



good for processing into different value added products. Red fleshed jackfruits, by and large have less aroma and sweetness but it has more consumer preference in Karnataka as compared to yellow flesh. Its Kannada name is 'Chandra Halasu', because the pulp in the ripe fruits resembles the colour of full moon. Most of the red flesh trees are seen on dry land areas, receiving rainfall anywhere between 600-800mm, resulting in good aroma, taste, Total Soluble Sugars (TSS) and pulp crispness. It has been noted that any colour shade between yellowish red, light red, light pink to dark red are all categorized by people as 'red jackfruit.' Toobugere and Gubbi taluks in have a major share of red fleshed Jack fruits. Among them, Red fleshed Jackfruit is more in Toobugere taluk. The intensity of red colour is also high with lot of variation in the red colour starting from light pink to orange and real red color. The density of red flesh trees is high in Toobugere area than Gubbi taluk." Though jackfruit trees are plenty in heavy rainfall districts of Karnataka like Dakshina Kannada, Uttara Kannada, Udupi, Shimoga etc, this belt has very few red jackfruits. One well-known exception is Mankalale Red variety near Sagar in Shimoga district that is both bright red and tasty.

Some of the red fleshed varieties popular among the farmers in Karnataka are as mentioned below



### ***K.Narasimhaiah***

Pink pulp, longer flakes, big fruits (15-20 kg) , high yielding (200-250 fruits at the age of 20 years and above)

### ***Byrachandra***

Selection made by Dr. S.V.Hittalamani, Retired Additional Director Horticulture (Fruits) – orange pulp, medium flake size, medium fruit size – 8-10 Kg, twice bearing.

### ***Kachahalli Kempu Siddappa***

Excellent type, with dark orange flakes, 10 to 11 cm length, yield is average-80-100 fruits, fruit size-10-15 Kg.

### ***Dasappa (Kanakapura Road)***

Light orange type, with bigger flakes 8-10cm, round fruits, 10-15 Kg size, yield-80-100 fruits.

Tamil Nadu Agricultural University (TNAU) has released improved Jackfruit varieties namely 'Palur-1' (in 1992), 'PPI Jack' (in 1996) and 'PLR (J)-2' (in 2006). 'Konkan prolific' is a prolific bearing jackfruit variety released in 2004 by the Regional Fruit Research Station, Vengurle. It is having an average yield- 420.56 kg/tree producing 73 fruits/ tree/year.

The characters of the some of the above varieties are detailed below





### **1. PLR.1**

It is high yielding with medium height, less spreading and suitable for high density planting. In addition to regular bearing season (April-June), it gives yield during off season (Nov-Dec) also. The annual yield per tree is about 80 fruits weighing around 900 kg. The average fruit weight is 12 kg containing 115-120 carpels. The off-season bearing is a unique trait of this variety. The fully ripe fruits have flat stigmatic surface instead of spiny surface. The fruit quality is good with attractive golden yellow carpels, which is very crispy and keeps well. The carpels are very sweet with high consumers appeal. TSS is 19<sup>0</sup> Brix. The seeds are also edible with high palatability.

### **2. PLR.2**

It is a clonal selection from Pathirakkotai Local of South Arcot district of Tamil Nadu. This variety has highly palatable flakes, with good keeping quality, bigger sized fruits. The incidence of major pest and diseases is less. With the season in June-December, the fruit yield per tree per year would be 95 to 110 in numbers and 1900 to 1950 kg in weight. This is suitable for growing in tropical climates and deep well drained loam soil.

### **3. PPI.1**

It is a clonal selection from Mulagumoodu local near Pechiparai of Kanyakumari district of Tamil Nadu. It is a



medium tall tree yielding 107 fruits per tree per annum (weighing 1818 kg) which accounts for 40.8 per cent more yield than local and has the maximum bearing tendency in tree trunks. The tree bears twice annually (April-June and November-December) and produces high quality crisp carpels with more TSS and ascorbic acid content. The flakes are sweet and tasty with pleasant.

### **4. Konkan prolific**

It is a selection released from Dr BSKKV, Dapoli, Maharashtra. The average plant height is 14.7 m with average spread of 11.5 m (N-S) and average girth of 1.10 m. Growth habit is semi spreading and fairly large with leaves dark green and alternate. The tree is monoecious with small male flowers held by pedicel. Female flowers are larger than the male and pedicel is thick. Fruit is a multiple type, medium size (8 to 9 kg), fruit's skin colour is green when immature and greenish yellow to brownish yellow when ripe. The fruit contains the edible, sweet, aromatic, crisply bulbs.

### **5. Singapore or Ceylon jack**

Ceylon jack or Singapore jack is introduced to South India. It is an early maturing variety and comes to bearing in about 18 months under favourable conditions in low elevation but may take more time at higher elevation. It is famous for its production of off-season fruits during



October to December apart from production of regular season fruits during June-July. The fruits are medium sized with small carpels, which are very sweet and fibrous.

### 6. *Velipala*

It is a local selection from the forests of Kallar in Tamilnadu and the trees are robust growing with very big fruits, the size ranging from 20 to 50 kg with bigger sized carpels. The fruits are noted for outstanding quality. Production of fruit per tree is less when compared to Singapore Jack but it is a regular bearer producing fruits during the main season. i.e., June-July.

### 7. *Hybrid jack*

Hybridization work attempted at State Horticulture Farm, Kallar, Tamil Nadu has resulted in the identification of hybrid jack. It is a cross between Singapore Jack and Velipala and it will produce fruits during regular and off-season (October-December). The individual fruit weight in the hybrid was 15.55 kg which was 42.69 percent more than the Singapore Jack.

### 8. *Muttam varikka*

Locally named variety in Tamilnadu, produces medium size fruits weighs of 7.0 kg with 46 cm length and 23 cm width with sweet flesh.



### 9. *Rudrakshi*

It produces small round fruits having smooth rind with fewer spines, quality is inferior.

In North Eastern India especially Assam, the jack fruits are broadly divided into two groups based on pulp characters- namely (i) soft and melting pulp and (ii) hard and crisp pulp.

(i) The soft pulp group is known locally as *Ghula* or *Ghila*. The mature pericarp is comparatively small in size. The juice is either thin or thick, colour varies from pale yellow to dark or golden yellow, taste is sweet or acidulously sweet. The exterior of the fruit is usually light green and occasionally brownish in colour. Surface is both smooth and pointed. The seeds are comparatively large. The leaves are somewhat small and round than those of the hard pulp group.

(ii) The hard pulp group is locally called *Karcha* or *Khujja*. The pulp is hard with apple like consistency; juice is scanty and sweet; pale yellow to whitish yellow in colour. In certain cases the edible pulp is half hard (basal end) and soft (apical end). Seeds are comparatively small. Spinescent rind is usually smooth or semi-blunt. The colour of the rind is usually pale brown and occasionally pale green. Leaves appear to be slightly more pointed, verdant and



bigger than those of the soft pulp group. Other types available are Gulabi (rose-scented), Champa (flavour like that of champak) and Hazari (bearing large number of fruits).

### *Exotic varieties*

Apart from the above local and improved varieties there are certain exotic varieties worth trying in our Indian conditions for further exploration of this wonder crop.

#### *i. Black gold*

It is a selection from Queensland, Australia. The tree is vigorous, with a dense and highly manageable canopy. With annual pruning, the tree is easily maintained at a height and spread of 2 to 2.5m, with consistent production of 55 to 90 kg per tree. The fruits are medium-sized, averaging 6.7 kg, with an edible flesh percentage of 35 per cent. The exterior of the fruit is dark green and has sharp fleshy spines. The spines do not flatten, or “open” upon maturity, making it difficult to judge the proper harvest time and maturity. The deep orange flesh is soft, with a strong, sweet flavour and aroma. The flesh is easily removed from the fruit compared with other cultivars.

#### *ii. Cheena*

It is a natural hybrid between jackfruit and champedak. The tree has an open, low and spreading growth habit and



can be maintained at a height and spread of 2.5 m with annual pruning. ‘Cheena’ consistently produces 50 to 70 kg per tree. The fruits are long, narrow and uniform in size and shape. The skin is green, with blunt spines that yellow and open slightly upon maturity. Fruit are small, weighing 2.4 kg and they have an edible flesh percentage of 33%. The flesh is deep orange, soft and somewhat fibrous, with an excellent flavor. The fruit have an intense, earthy aroma.

#### *iii. Cochin*

It is selection made in Australia. The tree is low in vigor and forms a sparse, upright and narrow canopy. The tree can be maintained at a height of 2 to 2.5 m (6.5 to 8.1 ft) and a spread of 1.5 m (4.9 ft) with light annual pruning. The fruits are small and smooth in comparison with other cultivars because the spines flatten and open as the fruit matures. Fruit weighs 1.5 kg, with 35 per cent edible fruit percentage. During some times of the year, the entire fruit can be eaten, including the “rag”. The flesh is firm and mild, with little latex. The tree often declines following moderate to heavy cropping.

#### *iv. Dang rasimi*

It is originated in Thailand. The tree is open, spreading and fast growing. It must be pruned annually to maintain a height and spread of 3 to 3.5 m. The trees are highly



productive, yielding 75 to 125 kg per tree, while maintaining vigorous growth. The fruits are bright green to pale yellow and uniform in shape if thinned to one fruit per fruiting spur. The skin has sharp spines that do not flatten or “open” with maturity. Fruits are medium to large, averaging 8 kg, with 32 per cent edible flesh percentage. The flesh is deep orange and firm. It has a mild, sweet flavour and a sweet, pleasant aroma. ‘Dang Rasimi’ is one of the most vigorous jackfruit cultivars, and must be annually pruned to maintain size.

#### *v. Golden nugget*

It is a selection from Queensland, Australia. The tree is fast growing, with a distinctive dark green, rounded leaf. It forms a dense, spreading canopy, which is easily maintained at a height and spread of 2 to 2.5 m. The fruits are small, green and rounded, with sharp, fleshy spines on the skin. The spines flatten to a smooth, golden-yellow upon maturity. The fruit weighs 3.2 kg, with an excellent edible flesh percentage of 41 per cent. The deep orange flesh is soft to medium firm depending on fruit ripeness. The flavor is excellent and the flesh has no fiber. ‘Golden Nugget’ fruit will often split open prior to ripening when there are heavy rains. Yields can be maintained at 60 to 80 kg per tree per year.



#### *vi. Golden pillow or Mong tong*

It was introduced to the Americas in the 1980s from Thailand. In its homeland of Thailand, it has attained a reputation as a fruit of distinctive beauty and quality. The tree is small and highly manageable with a height and spread of 3 m (10 ft). The fruit average 3.6 to 5.5 kg with 35 to 40 per cent edible flesh. There are typically 65 to 75 seeds per fruit and little latex. The flesh is thick and crunchy, with a golden colour. The flavour is mild and sweet, with no musky aftertaste. This cultivar is noted for precocious fruiting, bearing in the second year after planting.

#### *vii. J-30*

It is selection from Malaysia. The tree is vigorous, forming an open, conical canopy. The tree can be maintained at a height and spread of 3 m (9.8 ft) with annual pruning. The production per tree is 50 to 60 kg per year. Fruits are uniform and hang singly on the major limbs. The fruit are dark green and uniform, with blunt spines on the skin. The fruit weighs 7.6 kg, with an edible flesh percentage of 38 per cent. The flesh is deep orange and firm. The flavor is rich and sweet with only a slight aroma to the flesh and fruit.

#### *viii. J-31*

It is a selection from Malaysia. The tree is moderately vigorous, forming a spreading, open canopy. The tree can



be maintained at a height and spread of 2 to 2.5 m. Trees of this size can produce 42 to 60 kg per year. The fruits are large and irregular in shape with prominent, blunt spines. The weight is 12 kg, with an edible flesh percentage of 36 per cent. The flesh is deep yellow and firm with thick walls. The flavor is sweet and rich with a strong, earthy aroma. 'J-31' will often produce off-season fruit during the fall and winter.

#### *ix. 'Mia 1'*

It is an exceptional choice for the home owner searching for a vigorous, productive and delicious jackfruit. The tree begins to fruit within 2 to 3 years of planting. Fruit can reach 10 to 12 kg with a golden-yellow skin color. The flesh is crisp, sweet and delicious, with little latex. The tree can be maintained at a height and spread of 2 to 2.5 m.

#### *x. NS1*

It is selection from Malaysia and was among the first superior jackfruit cultivars successfully established in the Western Hemisphere. The tree is of medium vigour, forming a dense, upright canopy, which can be maintained at a height and spread of 2.5 to 3 m with moderate annual pruning. Production is heavy, with annual yields of 90 kg or more per tree. The fruits are dark green and blocky, with blunt, flattened spines. The fruit weighs 4.2 kg, with



a flesh percentage of 34 per cent. The spines flatten and open as the fruit ripen. The flesh is dark orange and firm, with a rich and sweet flavour.

#### *xi. Tabouey*

It is selection from Indonesia. The tree has small, dark green, rounded leaves and forms an open, rounded canopy. The tree can be maintained with a size and spread of 3 m (9.8 ft) with annual pruning. The tree produces moderate crops of 50 to 70 kg per tree. The fruits are long, thin and tapered at the stem-end. They are often misshapen and lobed, with a bright yellow colour and irregular, blunt spines. The fruit often split prior to harvest. The flesh is firm, pale yellow and has almost no aroma. Its flavour is mild and pleasant.



## INSECT PESTS MANAGEMENT

About 56 insect species belonging to 22 family and seven orders have been reported as pests of jackfruit. In India, 39 species of insect have been reported to occur on jackfruit of which only a few of them are known to cause economic loss to the crop (Butani, 1979). From South Karnataka (Bengaluru and Kolar districts) 31 species of insect pests belonging 20 families across seven orders have been recorded by Manjunatha (2002). Major insect species of the jackfruit, their bio-ecology and management are described hereunder.

### *1. Jackfruit shoot and fruit borer, Diaphania caesalis (Pyralidae: Lepidoptera)*

Jackfruit shoot and fruit borer is the most predominant insect pest that causes extensive crop losses in major jackfruit growing areas of India, Malaysia, Sri Lanka and Bangladesh. In India this pest is widely distributed across the jackfruit cultivating tracts and has been reported from several states viz., Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Bihar, Uttar Pradesh, Assam and Sikkim (Chowdhury and Majid, 1954; Alamet al., 1964).

Adult moths are medium in size (8-10 cm wing expansion) and whitish brown in colour. Wings possess greyish elliptical patterns and a series of black specs on the margins. Eggs



are laid either singly or in small groups on tender shoots, flower buds or fruits (Alamet al., 1964; Fletcher, 1914). Newly hatched larvae are yellowish with transparent body while the grown up larvae are reddish brown or dirty brown in colour with series of prominent black spots present all over the body. Larval period ranges from 15 to 19 days. Pupation takes place inside the feeding tunnel either in fruit or shoots. Occasionally pupation is also known to occur between two leaves and pupa is reddish brown in colour. This pest completes several generations in a year (up to 12 generations) and duration of life cycle ranges from 26 to 35 days depending on the season. Though, this pest is prevalent all around the year, peak infestation is normally noticed during January to March and May to October months (Manjunatha, 2002).

### *Symptoms :*

Upon hatching, early instar larvae stay gregarious and scrape the chlorophyll content on leaf buds, young leaves, tender shoots and fruits. Grown up larvae bore into tender shoot, flower buds and fruits; make tunnels inside and feed on the internal content. Larva is known to feed on seeds when the infestation is noticed on developed and ripened fruits (Manjunatha, 2002). Sometimes larvae web the leaves with silken thread and feed on leaflets by staying within the web. Because of extensive tunnelling, damaged shoots wilt



and dry; buds dry and drop down. On fruits, initially, small larval entry hole can be seen with deposition of fresh excreta at the entry point. At the later stages the size of the hole increases and paves the way for secondary infection by fungal pathogens. Damage on fruits lead to littering inside the fruit due to presence of excreta and rotting of fruit (Beeson, 1941; Nair, 1975; Tandon, 1993; Manjunatha, 2002).

### ***Management:***

- Remove and destroy affected leaves, flower buds, shoots and fallen fruits to minimize the spread of infestation
- Cover the developing fruits with perforated alkathene or polythene bags to prevent the infestation on fruits (Anonymous, 2012)
- Spray Profenophos 50 EC @ 1ml per litre of water on young shoots, flower buds and developing fruits to kill the eggs
- Spray Malathion 50 EC @ 0.5 per cent or Fenvalarate 20 EC 0.02 per cent or 4 per cent neem seed kernel extract (NSKE) on inflorescence (Manjunatha, 2002)
- Infestation can be minimized by regular pruning of dried branches within the canopy. Pruning



can be taken after the fruit harvest or at the end of the rainy season

### ***2. Jackfruit trunk borer, Batocera rufomaculata, B. Rubus (Cerambycidae: Coleoptera)***

Though this pest is not common on jack, it is a serious pest as severe infestation results in death of the tree. Apart from jackfruit, they have also been recorded as major pests of mango, fig and other forest trees. These species have relatively wider distribution across the India. Adult beetle of *B. rufomaculata* is large, measuring about 5 cm in length and 2 cm in width and possess long antennae. Body is greyish with a series of yellow spots on elytra and pronotum is ornamented with two orange-yellow crescent shaped spots (Atwal and Dhaliwal, 2012). Fully grown grub is fairly large measuring about 6 cm in length, yellowish white in colour and has very strong mandibles. Adults of *B. rubus* are slightly smaller than the other species, and are yellowish brown in colour. Thorax has two pink dots and lateral spines.

### ***Symptoms***

Eggs are laid under the loose bark or on wounds on stem and branches. Young larva feeds on bark for some time. Later, it bores into the main stem and or branches; make deep tunnels and feed on the internal tissues due to which supply of water and nutrients to the plant is affected. This



subsequently lead to wilting and drying up of branches and the tree is killed if appropriate control measures are not undertaken at the initial stage of infestation itself. Some of the prominent signs of infestation are yellowing of leaves of affected branch or whole tree if infestation is on trunk, prominent and large bored holes on tree trunk or branch, chewed plant tissue with excreta coming out from entry hole, deposition of wood powder at the base of the tree and oozing of brown gummy substance from the bored holes. Fruits yield drops radically in infested trees and under severe infestation condition whole tree is killed.

#### **Management:**

- Prune and destroy severely affected (dried up) tree or branches along with grubs and pupae to prevent the spread of infestation
- Clean the bored hole and hook out or kill the grub using cycle spoke or metal wire
- Insert cotton ball soaked in Dichlorvos 76 EC insecticide solution (5 ml in one litre of water) into bored hole or inject the insecticide solution using syringe (without needle) or place two aluminium phosphide tablets inside hole and seal the hole with wet clay or sealer cum healer powder developed by IIHR (Anonymous, 2012).



### **3. Bud weevil, *Ochyromera artocarp*, *Onychocnemis careyae*, *Telurops ballaradi* (Curculionidae: Coleoptera)**

Adult weevils are small to medium sized, greyish brown in colour. Eggs are laid on tender flower buds, twigs or fruits. Grubs are soft bodied and appear white in colour. Both adults and grubs cause loss to jack.

#### **Symptoms**

Grubs bore into tender flower buds and fruits as a result of which the damaged parts rot and fall down prematurely. Adults nibble leaves by making small leaves and cause defoliation (Muthukrishnan et al., 2004).

#### **Management:**

- Mechanical collection and destruction of grubs and adult weevils
- Spray Malathion 50 EC @ 2ml per litre of water

### **4. Spittle bug, *Cosmoscratarelata*(Cercopidae: *Hemiptera*)**

These bugs secrete frothy mass over their body and hence the name spittle bug. This pest is more serious on jack in South India. Adults are medium to large in size and has reddish head and pronotum. Forewings possess reddish markings. Nymphs normally live inside the mass of froth





found on young shoot and developed & ripening fruits. After the final moult, nymphs become adults and leave the frothy mass. Total life cycle is completed in about two months.

### **Symptoms**

Adult bugs insert eggs in tissues of tender twigs. Nymphs normally occur in swarms. Both nymphs and adults suck sap from tender twigs, shoots and leaves. Affected leaves turn to yellow colour which eventually curl and dry up. Infested tender shoot also dries up resulting in weakening of the tree. Fruit set is adversely affected in infested tree. During heavy infestation, spitting or frothy mass can be observed on the ground at the base of the tree. Normally infestation by this pest species commences in the month of December- January coinciding with flowering and peak levels are noticed during the month of March (Jayaraj and Ananthan, 2009; Muthukrishnan, 2004).

### **Management:**

- Removal and destruction of affected shoots
- Collection and destruction of nymphs along with frothy mass will not only help in subsiding the infestation levels but also prevents the further spread
- Pruning of dense branches after the fruit harvest helps in minimizing the pest incidence



- Spraying of Quinalphos 25 EC @ 0.05 per cent or neem oil 0.03 per cent at the time of flowering reduces damage (Jayaraj and Ananthan, 2009)

### **5. Bark borer, *Indarbella tetraonis* (Indarbelidae: Lepidoptera)**

It is a polyphagous pest, apart from jack it also infests on guava, sapota, citrus, pomegranate, mango, drumstick, litchi, jamun and a number of forest and ornamental trees.

### **Symptoms**

Adult female moth lays eggs in small batches under the bark. On hatching young larvae initially nibble on the bark for a few days. Later, larvae bore into bark, form short tunnels and feed on the cambium layer. Sometimes during heavy infestation, larvae also bore into the main stem. Wood dust and fecal pellets in the form of the silken web running on the stem is an indication of infestation. Further, gummy exudation and chewed up wood material can be seen on the damaged portion. Due to infestation, translocation of cell sap is disrupted, tree is weakened and fruiting capacity is reduced.

### **Management:**

- Remove and destroy the damaged branches. This practice will prevent the larvae from boring into the main trunk



- Collect eggs and grubs under the bark and destroy them
- Swab the trunk with Chlorpyrifos 20 EC or Quinalphos 25 EC @ 5ml per litre of water as a precautionary measure to prevent the egg laying
- Clean the damaged bark portion, insert the cotton plug/ball soaked in kerosene or inject 10 ml of kerosene or petrol or chloroform plus creosote (2:10) and seal the hole with wet mud or cement (Murthukrishnan, 2004)

**6. *Mealybugs, Drosicha mangiferae* (giant mealybug) ; *Ferrisia virgata* (white-tailed mealybug); *Nipecoccus viridis* (*Pseudococcidae: Hemiptera*)**

These species are widely distributed across India and are polyphagous pests infesting many other fruit crops viz., mango, guava, citrus, grapes, ber, fig etc.

***Symptoms***

Nymphs and adults are covered with white waxy material. Nymphs and adults stay in clusters and suck sap from leaves, shoots and inflorescence.

***Management***

- Keep fields free from weeds and practice clean cultivation



- Deep plough or rake up the soil around the tree trunk and expose the eggs to sunlight and natural enemies
- Tying of alkathene band on tree trunk to prevent migration of crawlers from soil to tree
- Crawlers normally congregate below the alkathene band, to kill them spray crude garlic oil @ 10 ml/ litre of water (Anonymous, 2012) or fish oil rosin soap (FORS) @ 20g/ litre of water. This will help in minimizing damage on natural enemy population (lady bird beetles, spiders) when they are abundant.
- When infestation is severe, spray insecticides viz., Thiodicarb 75 WP @ 1.25 g or Profenofos 50 EC @ 2.5 ml or Acephate 75 SP @ 4g or Quinalphos 25 EC @ 4 ml in one litre of water (Tanwaret. al.,2007)

**7. *Aphids, Greenidia artocarpri, Toxoptera aurantii* (*Aphididae: Hemiptera*)**

Activity of aphids on jack is largely observed between February and October months. *Greenidia artocarpri* is predominantly seen only on jack.

***Symptoms***

Aphids congregate in colonies on under surface of leaves and suck the sap (Muthukrishnan, 2004). Infested leaves



distort and when infestation is prolonged tree loses vigour. Aphids secrete honey dew as a result of which black sooty mould develops on leaf and shoot surfaces. This eventually results in reduction in photosynthetic activity.

**Management:**

Spraying of Acephate 75 SP @ 1.5 g or Imidacloprid 200 SL @ 0.25 ml or Dimethoate 30 EC @ 2ml or Azadirachtin 10000 ppm @ 2ml per litre water gives good protection

**8. Fruit fly, *Bactrocera dorsalis* (Tephritidae: Diptera)**

Oriental fruit fly, *Bactrocera dorsalis* is one of the most destructive pests and has been recorded damaging on more than 150 fruit and vegetable crops.

**Symptoms**

Adult female insert eggs with the help of strong needle like ovipositor into the jack fruit. Maggots stay inside the fruit and feed on internal contents. Infested fruits drops off before attaining maturity. Maggots undergo pupation in soil.

**Management:**

- Collect the fallen infested fruits and bury them in soil or burn



- Erect Methyl eugenol traps at 3 to 6 feet height on jack tree. It would be necessary to add a few drops of Dichlorvos 76 EC insecticides on either sides of Methyl eugenol lure and after 3 to 4 weeks add another fresh lure into the trap (Anonymous, 2012).
- When infestation is severe, mix 100 grams of jaggery and 5 ml of insecticide (Malathion 50 EC or Deltamethrin 25 EC) and swab it on tree trunk as bands up to 3 feet from the ground level. Following this practice at weekly to ten days interval during fruit maturity stage gives very good protection from fruit flies.

**9. Fruit borer, *Conogethes punctiferalis* (Pyralidae: Lepidoptera)**

Through it is major pest of castor, guava and cardamom; in some places it also causes considerable fruit damage on jackfruit. Moths lay eggs on flower buds and young fruits.

**Symptoms**

Larva bores into to flower bud or fruit and feeds on internal contents (Muthukrishnan, 2004). Most often the larval entry hole on fruits is plugged with the excreta.



### **Management:**

- Remove and destroy affected parts
- Spray Malathion 50 EC @ 2ml per litre of water during fruit set stage. If necessary, after two weeks, second spray may be given with Chlorpyrifos 20 EC or Quinalphos 25 EC @ 2ml per litre of water.

### **10. Jack leaf webber or hairy caterpillar: *Perinanuda (Lymantriidae: Lepidoptera)***

This pest is usually active during rainy season and it is a sporadic pest on jack. Eggs are laid in small groups on leaves (Atwal and Dhaliwal, 2012).

### **Symptoms**

Larvae web the leaves using silken thread, stay inside the web and scrap the green matter on leaves irregularly and cause extensive defoliation.

### **Management:**

- Mechanical collection and destruction of leaf webs along with caterpillar
- Spraying of Chlorpyrifos 20 EC or Quinalphos 25 EC @ 2ml per litre water. For effective control ensure that the spray is directed on upper surface of the leaf (Atwal and Dhaliwal, 2012).



Other minor pests of jackfruit are scale insects, *Icerya aegyptiaca*, *Cercoplastes rubens*; whitefly, *Aleurotrachelus caeulescens*, *A. rachipora*; thrips, *Pseudodendrothrips dwivarna*; termites, *Glyptotermes ceylonicus*; ants, *Oecophylla smaragdina*



*Shoot and fruit borer*



*Jackfruit trunk borer*



*Jackfruit borer damage*



## DISEASE MANAGEMENT

The plant genus *Artocarpus* comprises roughly 50 species of tropical trees native to the Pacific and South and Southeast Asia, several of which produce edible fruit. Jackfruit, *Artocarpus heterophyllus*, is a popular garden species prized for its edible flowers, fruit, and seeds for fresh consumption or cooking. Jackfruit trees can reach over 60 ft in height and bear fruit that can be 2 feet or more long and weigh as much as 20kgs. In recent years, this wonderful tree is affected with many of the diseases. Symptomology and management of these diseases are described here.

### 1. *Rhizopus* Fruit Rot:

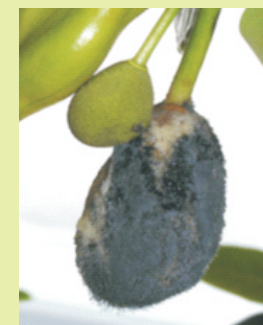
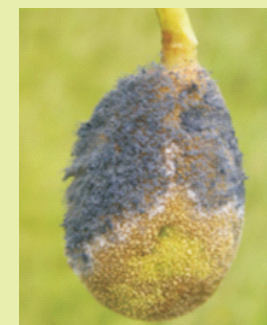
Rhizopus rot is a common fungal disease of jackfruit flowers and fruit. Rot is more likely to occur in high-rainfall areas or during and after stormy periods. When warm, humid, wet weather coincides with the flowering and fruiting season, rhizopus rot can cause total loss of fruit in jackfruit trees.

#### *Symptoms:*

At first, soft, watery, brown spots develop on the flowers and fruit. Subsequently, a powdery, fuzzy-looking mass of



black spores and white fungal mycelia covers the jackfruit surface. The pathogen engulfs the young fruit, resulting in the characteristic black, rotten, shrunken, and sometimes mummified fruit remains. Fruit symptoms can appear on the tree or can develop on fruit that are in storage or transit.



Three species of plant-pathogenic fungi of the genus *Rhizopus* can cause this disease in the tropics: *Rhizopus oryzae*, *Rhizopus artocarpi*, and *Rhizopus stolonifer*. No jackfruit varieties are reported to have significant resistance to the disease.

Warm, humid, rainy conditions favor the development of rhizopus rot. Wind, rain, and insects dislodge and spread the tiny fungal spores. When deposited on moist fruit surfaces, the spores germinate and infective mycelia grow into the tissues. The infection produces a layer of black spores on the fruit surface to start secondary cycles of infection and disease. Although wounds can predispose the fruit to infection, unwounded flowers and young fruit



are also susceptible. *Rhizopus* can survive on decaying plant litter or in the soil to initiate new infections.

**Management:**

- Prune the tree to encourage good ventilation and to reduce relative humidity in the canopy.
- Remove and destroy diseased fruit from trees and the ground. Clean up decaying organic debris within and around the tree. Ensure that water does not pond around the tree's root zone.
- Control weeds around young trees.
- Intercrop jackfruit with trees that are not susceptible to infection by *Rhizopus*.
- Keep ripe fruit from contact with the soil or decaying organic material.
- Avoid wounding the fruit. Wash fruit after harvest in clean water and dry thoroughly before packing or transporting.
- Avoid storing fruit after harvest in hot, poorly ventilated containers.
- Where disease is severe, protect fruit with spraying with Copper oxy chloride at the rate of 3gms per litre.



**2. Leaf spot (*Colletotrichum gloeosporioides*) :**

It is most common disease occurring on Jackfruit. The disease is characterized as dark brown to brick red spot on both the leaf surfaces. These spots later turn into greyish white centres with dark brown boundaries.

**Symptoms**

Dark coloured acervuli of the fungus are observed on greyish region which, when torn, ooze out profuse spore masses. The fungus has been seen to infect the young tender shoots and petioles of the leaves also.



**Management:**

- The disease is effectively checked through the sprays of carbendazim (0.1 per cent) or methyl thiophanate (0.1 per cent) or captafal (0.2 per cent) or chlorothalonil (0.2 per cent).

**3. Die-back (*Botryodiplodia theobromae*):**

It is a destructive disease of Jackfruit. die-back disease caused a serious damage in many planting areas in south asia including India.



### ***Symptoms***

The onset of die-back becomes evident by discolouration and darkening of the back some distance from the tip. The dark area advances and young green twigs start withering first at the base and then extending outwards along the veins of leaf edges. The affected leaves turn brown and their margins roll upwards. At this stage, the twigs or branches die, shrivel and fall, and there may be an exudation of gum from affected branches. Such branches have also been found to be affected by shoot borers and shot hole borers. The infected twigs show internal discolouration when split open. In early stages, epidermal and sub-epidermal cells of twigs are often slightly shrivelled. On such twigs, erumpent acervuli of *Colletotrichum gloeosporioides* are also observed.

### ***Management:***

- To check this disease, pruning of infected twigs followed by spraying of carbendazim (0.1 per cent) or Topsin M (0.1 per cent) or chlorothalonil (0.2 per cent) have been found effective (Rawal and Saxena 1997).
- The control of shoot borers and shot hole borers by spraying suitable insecticides is also recommended.



### ***Pink disease (Botryobasidium solmonicolor):***

It is widespread in tropical and subtropical areas.

### ***Symptoms***

The disease appears as a pinkish powdery coating on the stem. Pink colour represents profuse conidial production of fungus. Young woody branches of the affected trees loose their leaves and show die-back. Similar disease has also been recorded on mango.

### ***Management:***

- The affected branches should be pruned and the cut end should be pasted with bordeaux paste or copper oxychloride.



## VALUE ADDITION

Jack fruits versatility is due to its potential for value addition. More than 100 items can be prepared from jack fruit right from immature stage to well ripened stage. Each item has its own virtues in terms of taste, preference, keeping quality etc. A glimpse of the potentiality of the fruit for processing and value addition is as follows:

### Value addition in Jackfruits

Sl. No.	Stage of fruit	Items that can be prepared	Remarks	Type suitable
1.	Immature	Culinary Preparations	Fresh consumption	Both firm and soft
2.		Cutlets	Fresh consumption	Both firm and soft
3.	Half mature	Pickle	Can be preserved	Both firm and soft
4.	Fully mature	Cutlets	Fresh consumption	Both firm and soft
5.		Pulao/ Biryani	Fresh consumption	Both firm and soft
6.		Papad	Can be preserved	Firm type preferred
7.	Fully mature	Cutlets	Fresh consumption	Both firm and soft
8.		Chips	Can be preserved	Firm type preferred
9.		Pakoda	Fresh consumption	Both firm and soft



Sl. No.	Stage of fruit	Items that can be prepared	Remarks	Type suitable	
10.	Well Ripened	Pulp (Base material)	Can be preserved	Both firm and soft	
11.		Halwa	Can be preserved	Both firm and soft	
12.		Gulab Jamun	Fresh consumption	Both firm and soft	
13.		Sweet vada/Idli	Fresh consumption	Both firm and soft	
14.		Miniappam (Unniappam)	Fresh consumption	Both firm and soft	
15.		Leather	Can be preserved	Both firm and soft	
16.		Jam	Can be preserved	Both firm and soft	
17.		Custard	Fresh consumption type preferred	Firm	
18.		Wine	Can be preserved	Both firm and soft	
19.		Well ripened	Squash	Can be preserved	Both firm and soft
20.			Kheer/ Payasam	Fresh consumption	Both firm and soft
21.			Mocktail	Fresh consumption	Both firm and soft
22.		Seeds	Cake	Fresh consumption	Both firm and soft
23.			Culinary	Fresh consumption	Both firm and soft preparations
24.			Pakodas	Fresh consumption	Both firm and soft
25.	Kheer/ Payasam		Fresh consumption	Both firm and soft	
26.	Seeds	Starch Flour	Can be preserved	Both firm and soft	





## Recipes

Jackfruit is a potential raw material for value addition. Several delicious products can be made out of jackfruit right from immature fruit to seeds. In South East Asia and particularly in South India delicious recipe are prepared. The recipes of few items that can be made out of different stages of jackfruit are furnished below:

### From immature jackfruit Ready to cook tender jack

#### Ingredients

Jackfruit (tender/immature) - 1 kg  
Sodium hypochlorite - 25-50 g  
Sterile water - 2 ltr.

#### Method

- Select good quality tender jack
- Remove outer peel using a clean knife
- Wash with sterile water with 10 per cent sodium hypochlorite
- Cut the treated fruit into small pieces
- Blanch the pieces for 3 minutes in hot water
- Pack the pieces in Low-density polyethylene (LDPE) bags using hand wrapper
- It can be stored below 18<sup>o</sup> C for 10 days

*Courtesy: [www.thesmilearchitects.com](http://www.thesmilearchitects.com)*



## Tender jack bhaji (South Indian style)

#### Ingredients:

Jackfruit (tender/immature) - 250 g  
Green chillies - 5 to 6  
Mustard seeds - 2 teaspoon  
Asafoetida - 1 teaspoon  
Curry leaves - 10-15 leaves  
Coconut (Grated) - 1 table spoon  
Jaggery - 10 g  
Salt - to taste  
Oil - 20 ml

#### Method:

- Heat oil in pan
- Season with mustard seeds. After they burst, add asafoetida, curry leaves, followed by green chillies and stir well till fried.
- After the above get fried well, add finely chopped jackfruit pieces, coconut
- Jaggery and salt to taste
- After the jackfruit pieces get cooked well, it can be consumed.

*Courtesy: [www.curryworld.worldpress.com](http://www.curryworld.worldpress.com)*



## Tender jack bhaji (North Indian style)

### *Ingredients:*

Jackfruit (tender/immature) - 250 g  
Cumin seeds - 1 teaspoon  
Red chilli powder - 1 teaspoon  
Coriander powder - 2 teaspoon  
Garlic - 6-7 cloves  
Ginger - 1 inch piece  
Onion (medium size) - 1 (finely chopped)  
Tomato puree - 1/2 teaspoon  
Oil - 2 to 3 tablespoon  
Salt - to taste

### *Method:*

- Heat oil in pan
- Deep fry the jackfruit pieces till golden colour, drain from oil and keep aside.
- Remove half oil from kadai. In the remaining oil, splatter cumin seeds.
- Add ginger garlic paste and then finely chopped onion to the oil.
- After it turns brown, add chilli powder, coriander powder and tomato puree.



- Cook well till oil leaves the paste.
- Add enough of water to get thick gravy. Then add the fried jackfruit pieces and required salt.
- Boil together till the jackfruit pieces turn tender
- Add garam masala, boil for few minutes, garnish with coriander leaves and serve hot.

*Courtesy: [www.maayeka.blogspot.com](http://www.maayeka.blogspot.com)*

## Half matured jackfruit

### Jackfruit Pickle (North Indian type)

### *Ingredients*

Jackfruit (half matured) - 1 kg raw  
Salt - 100 g  
Chilli Powder - 30 g  
Fennel seeds - 2 teaspoon  
Fenugreek seeds - 1 tea spoon  
Asafoetida power - 1 tea spoon  
Mustard seeds - 3 tea spoon  
Onion seeds /Kalonji - 1/2 teaspoon  
Turmeric Powder - 1 teaspoon  
Vinegar - 100 ml  
Mustard Oil - 1/2 litre



### *Method:*

- Select a jack fruit that is not fully matured.
- Remove or scrap away the green outer rind. Then, cut the jackfruit into big pieces along with seeds.
- Cook the jackfruit pieces in boiling water until soft.
- Drain, apply salt and keep aside spread on a plate for complete drying.
- Heat 2-3 teaspoon of oil and roast the mustard, fennel, fenugreek and Kalonji seeds.
- Cool the roasted spices and finely powder them.
- Heat oil in a broad mouthed cooking pan, add turmeric powder, chilli powder, asafoetida. After putting off the stove, add the above ground mixture.
- After the oil cools down, add the dried jackfruit pieces which should be thoroughly free from moisture.
- Then add vinegar, mix well and store in a clean dry sterilized bottle.



## **Jackfruit Pickle (South Indian type)**

### *Ingredients*

- Jackfruit (half matured) - 1 kg
- Garlic - 100g
- Ginger - 100g
- Green chillies - 100g
- Gram flour /Besan - 50g
- Red chilli powder - 2 table spoons
- Turmeric powder - 1 tea spoon
- Curry leaves - 2-3 sprigs
- Oil - ½ ltr
- Vinegar - 200 ml
- Asafoetida powder - 2 tea spoon
- Cumin seeds - 1 table spoon
- Fenugreek seeds - 1 table spoon
- Salt - to taste
- Sugar - to taste

### *Method*

- Select a jackfruit that is not fully matured. Remove or scrap away the green outer rind. Then, cut the jackfruit into big pieces along with seeds.
- Dry roast cumin and fenugreek seeds and finely powder them.



- Heat oil in a broad mouthed cooking pan and fry chopped garlic, ginger, green chillies and curry leaves
- Add jack pieces and fry for 10 mins
- Add salt, chilli powder, turmeric powder, gram flour and vinegar
- Remove from flame and add asafoetida and cumin – fenugreek powder
- Add sugar, mix well, cool and store in a clean dry sterilized bottle

## Fully matured unripe jackfruit

### Jackfruit cutlet

#### Ingredients

Jackfruit - ½ kg

Onion - 3 Nos.

Green chillies - 6 Nos.

Pudina - few leaves

Coriander leaves - ½ bunch

Curry leaves - 2-3 sprigs

Ginger - ½ inch

Garlic - 6 to 7 cloves

Garam masala - 1 teaspoon

Ginger garlic paste - 2 teaspoon



Gram flour - 3 Teaspoon

Turmeric powder - 1/2 teaspoon

Red chilli powder - 1 teaspoon

Oil - 500 ml

Salt - to taste

Egg - 2 Nos.

Bread crumbs - Available in market (or) Make crumbs by beating 6 to 7 slices of bread in mixer

#### Method

- Cut open mature unripe jackfruit. Remove bulbs and extract out the seeds.
- Chop the bulbs into small pieces
- Chop onion, garlic, ginger, coriander leaves, pudina and curry leaves into small pieces
- Heat oil and fry onion followed by garlic, ginger, coriander leaves, pudina, curry leaves, green chillies and ginger-garlic paste. Then add jack fruit pieces. Allow it to cook till soft. Then, allow it to cool for 10 minutes.
- Add garam masala, gram flour, red chilli powder, turmeric powder and salt to taste, to the above mixture.



- Take egg white and beat.
- Moisten your palm, make small balls of jackfruit cooked mixture, flatten the ball by gently pressing and dip in egg white
- Roll it in bread crumbs
- Deep fry in oil and serve hot.

### Jack fruit papad

#### *Ingredients*

Mature /raw jackfruit bulbs - 500 g

Salt - 2 tea spoon

Black sesame or cumin seeds - 2 tea spoon

#### *Method*

- Cut open mature unripe jackfruit. Remove bulbs and extract out the seeds.
- Boil the bulbs, drain well and grind into fine paste along with salt using mixer
- Mix ingredients like sesame or cumin seeds
- Flatten into layer of fine thickness
- Dry in trays of electric or solar cabinet drier/ by open sun drying
- Deep fry and serve



### Masala papad

#### *Ingredients*

Raw jackfruit - 500 g

Green chilli - 6 Nos.

Curry leaves - 2 sprigs

Garlic - 6 cloves

Ginger - 1 inch

Cumin seeds - 2 tea spoon

Salt - to taste

#### *Method*

- Cut open mature unripe jackfruit. Remove bulbs and extract out the seeds.
- Boil the bulbs and grind into fine paste along with green chilli, ginger, garlic and curry leaves using a wet grinder / mixer
- Mix all the other ingredients like cumin seeds and salt
- Flatten into layer of fine thickness
- Dry in trays of electric or solar cabinet drier/ by open sun drying
- Deep fry and serve



## Jackfruit chips

### Ingredients

Well matured jackfruit bulbs - 1 kg

Salt - to taste

Water - to blanch

Oil - 500 ml

### Method

- Cut open mature unripe jackfruit. Remove bulbs and extract out the seeds
- Cut the bulbs in to shreds of 0.5 to 0.6 cm width, maintaining the length as much as the bulb
- Blanch the pieces in boiling water in which salt has been added for two minutes and allow to drain till completely dry
- Heat oil in a frying pan and fry the chips. Add 1-2 spoons of salt water in oil while frying.

*NB. Frying without blanching or over cooking results in hard chips*

## Jackfruit bajji

### Ingredients

Well matured jackfruit bulbs - 500 g



Gram flour - 250 g

Chilli powder - 2 teaspoon

Turmeric powder - 1 teaspoon

Pepper powder - ½ teaspoon

Cumin powder - ½ teaspoon

Salt - to taste

Oil - 500 ml

### Method

- Cut open well mature unripe jackfruit. Remove bulbs and extract out the seeds.
- Cut one bulb into two pieces
- Add salt, chilli powder, turmeric powder, jeera powder and pepper powder to gram flour and mix well by adding water till medium consistency.
- Dip the fruit pieces into the batter
- Heat oil in frying pan and deep fry in hot oil till they turn golden brown.

## Jackfruit pakodas

### Ingredients

Well matured jackfruit bulbs - 500 g

Onions - 3 Nos.

Green chilli - 8 Nos.



Coriander leaves - half bunch

Curry leaves - 2-3 sprigs

Gram flour - 200 g

Chilli powder - 2 teaspoon

Salt - to taste

Oil - 500 ml

### ***Method***

- Cut open well mature unripe jackfruit. Remove bulbs and extract out the
- seeds
- Shred the bulbs in to small pieces, add chopped onion, green chilli, curry leaves and coriander leaves.
- Add gram flour, salt and chilli powder to the above; mix well by adding water till required consistency.
- Make small to medium sized balls and deep fry in oil

## **Jackfruit biryani**

### ***Ingredients:***

Jackfruit - unripe 750 g (500 g with seeds and 250 g without seeds)

Onions - 200 g



Green chilies - 4 Nos.

Ginger - ½ inch piece

Garlic - 7-8 pods

Oil - 200 mg

Coriander leaves - small bunch

Salt - to taste

Lime - 1 No.

Rice - 500 g

## ***Preparation of Garam Masala***

### ***Ingredients***

Coriander seeds - 15 g

Cloves - 6 or 7

Pepper - 10 No.

Cumin - 1 teaspoon

Black cuiun - ½ tea spoon

Cinnamon - 2 No.

Cardamom - 1 No.

Red chili - 5 Nos.

### ***Method to prepare garam masala***

Dry roast all ingredients required for garam masala and powder them for later use.



### ***Method to prepare jackfruit biryani***

- Peel jack and separate out 500 g of bulbs as big pieces along with seeds.
- Besides this, take 250 g of bulb after removing seeds and shred or cut them into 2- 4 pieces
- Fry the shred pieces into chips.  
Blanch the bigger pieces in hot water for 5 minutes and keep aside.
- Chop onion and keep aside
- Grind green chillies, ginger, garlic into smooth paste
- Boil water and cook rice. Just when it splits, drain water, add salt, 2 teaspoon oil and keep aside
- In a pan, heat oil, add ginger, garlic and green chilli paste, onion and fry till golden brown.
- Add 500 g of blanched jackfruit pieces and fry till soft
- Add garam masala powder, cooked rice, salt, lemon juice and stir well
- Garnish with golden brown onion, coriander leaves and chips (fried of jackfruit)
- Serve hot with curd.



### ***From well ripe jackfruit***

#### ***Jackfruit pulp (Basic recipe)***

##### ***Ingredients***

Jackfruit pulp - 1 kg

Jaggery - 1 kg

Ghee - 200 g

Water - 1 ltr.

##### ***Method:***

- Cut open well ripe jackfruit. Remove bulbs and extract out the seeds.
- Boil the ripe bulbs with minimum required water till they turn soft.
- Drain the excess water and grind the bulbs into a smooth pulp using mixer
- Prepare jaggery syrup by dissolving one kg of jaggery in one litre of water.
- After the syrup boils add jackfruit pulp and ghee
- Mix well and stir continuously till the pulp is thick in consistency





## **Jackfruit Halwa**

### **Ingredients**

Jackfruit pulp - 200 g

(Basic recipe)

Water - 1 cup

Ghee - 1/2 cup

Sugar - 1 cup

Cashew nuts - 10 Nos.

Maida - 1 teaspoon

### **Method:**

- In a broad vessel with thick base, add sugar, basic recipe, water and maida and mix well. When it starts boiling, add cardamom, ghee roasted cashewnut and ghee
- Stir till it thickens to consistency of halwa
- Apply ghee to tray /plate and spread.
- Allow it to cool, cut and serve.

## **Gulab jamum**

### **Ingredients**

Jackfruit pulp - 5 tea spoon

(Basic recipe)

Maida - 2 tea spoon



Milk powder - 2 tea spoon

Ghee - 1 table spoon

Cardamom powder - 1 teaspoon

Sugar - 250 g

### **Method :**

- Add maida and milk powder to basic jack fruit pulp
- Add 2-3 drops of vanilla essence and cardamom powder and make smooth dough
- Make sugar syrup by adding 250 g of sugar in 250 ml of water. After the syrup boils, simmer the flame and leave for 5 mins to get the required thin consistency sugar syrup
- Make small balls of dough, deep fry in ghee and soak in sugar syrup.

## **Jackfruit unniyappam (mini appams)**

### **Ingredients**

Jackfruit pulp - 250 g

(Basic recipe)

Rice flour - 250 g



Black sesame - 50 g  
Cardamom powder - 2 tsp  
Coconut - 1/2 (finely chopped into cubes)  
Salt - 1/2 to 1 teaspoon

**Method:**

- Fry the finely chopped coconut cubes/ pieces in ghee
- Add rice flour, sesame seeds, cardamom powder, roasted coconut pieces and pinch of salt to basic recipe.
- Mix well the above ingredients in to a smooth dough, without adding water
- Roll into small balls and deep fry in oil.

**Jackfruit sweet vada**

**Ingredients**

Jackfruit pulp - 250 g  
(Basic recipe)  
Maida flour - 250 g  
Baking powder - 1 tsp  
Sesame seeds - 50 g  
Cardamom powder - 2 tsp  
Salt - 1/2 to 1 teaspoon



**Method:**

- Add maida flour, sesame seeds, cardamom powder, baking powder and pinch of salt to basic recipe.
- Mix all the above ingredients in to a smooth dough, without adding water
- Roll into balls, flatten on a greased surface, pierce a hole with finger and deep fry in oil

**Jackfruit custard**

**Ingredients**

Milk - 1/2 litre  
Custard Powder - 4 teaspoon  
Sugar - 500 gms  
Jackfruit bulbs - 1/2 kg (ripe)

**Method**

- Add custard powder to milk, mix well and boil it.
- Add sugar to boiling milk and boil for few more minutes
- After the milk cools to room temperature, refrigerate it for 4-5 hours / till the required semi solid consistency is reached.
- Cut ripe jack fruits into small pieces, add to the custard and serve



## ***Jackfruit wine***

### ***Ingredients***

Jackfruit (ripe) - 1 kg

Sugar - 500g

Water - 1 ltr

Yeast - ½ teaspoon

Cinnamon - 2 inch bark

Poppy seeds - 10 Nos.

Cardamom - 2-3 No.

Star anise - 1 No.

Cloves - 2-3 Nos.

### ***Method***

- Cut open well ripened jackfruit. Remove bulbs and extract the seeds.
- Cut the well ripened bulbs into small cubes
- Wrap all the spices in a muslin cloth and keep aside
- Boil and cool the water in a vessel with lid
- Add jack pieces, sugar, and the wrapped spices.
- Add yeast for fermentation.
- Close the lid
- Stir regularly for 20 days
- After 20 days, strain and store the wine in a clean glass bottle



## ***Jackfruit kheer***

### ***Ingredients***

Pulped ripe jackfruit bulbs - 500 g

Rice flour - 50-100 g

Coconut - 1 No.

Milk - 250 ml

Cardamom powder - 1 teaspoon

Jaggery - 200 g

Dry fruits - 100 g

Ghee - 100 g

### ***Method of extracting coconut milk***

- Grate the coconut
- Put the grated coconut into a mixer jar, add equal volume of warm water and run the mixer for 15 seconds
- It can be done in batches if the mixer jar is too small for the grated coconut)
- Extract the coconut milk by squeezing the ground coconut. This is called the first coconut milk. Keep it aside. Pool all the first milk extracted if done in batches.



- Then, add the coconut residue that is left out after the extraction of the first coconut milk in to the mixer jar. Add equal volume of warm water and run the mixer for 10-15 seconds.
- Again repeat the extraction by squeezing the ground coconut residue. This is called the second coconut milk. Pool all the second milk extracted if done in batches.

### ***Method of making rice flour balls***

- Make a smooth dough of rice flour with hot water
- Make small balls of the dough (roughly 1 cm diameter)
- Boil water in a pan.
- Drop the balls of rice flour
- The balls get cooked well in 10-15 mins
- Then, drain the excess water and keep the cooked balls aside.

### ***Method of making jaggery syrup***

- = Dissolve 200g of jaggery in 200 ml of water thoroughly
- = Cook in an open pan and stir



- Allow it to boil. After it boils, strain it through a metal strainer to remove any dirt or dust and keep aside
- The strainer should be washed immediately to avoid clogging of fine holes in the strainer

### ***Method of making kheer***

- = Cut open well ripe jackfruit. Remove bulbs and extract out the seeds.
- = Cut the well ripe bulbs into small cubes. Blend it smooth with a mixer.
- = In a pan add jackfruit pulp and the second coconut milk extracted
- = Stir well for thorough mixing and boil to get a smooth blend of pulp and coconut milk. Add little water if required.
- = After it starts boiling, add the cooked rice flour balls into this blend
- = Add the first coconut milk extracted to it.
- = Then add milk, cardamom and jaggery syrup that was already prepared
- = Garnish with dry fruits and nuts roasted in ghee.



## **Jackfruit pudding**

### **Ingredients**

Ripened jackfruit - 500 g  
Sugar - 250 g (or as required)  
Cream/condensed milk - 150 g  
Milk - 500 ml  
China grass - 20 g  
Vanilla essence - 1 teaspoon

### **Method**

- = Cut china grass into small pieces. Add in a glass of water and keep it aside.
- = Boil milk, sugar and the china grass water .
- = Cook and pulp the well ripe jackfruit.
- = Add the pulp to the milk mixture and stir on a slow flame till a thick custard consistency is formed. Add cream and essence.
- = Cool in the fridge for about 2 hrs and serve.

## **Jackfruit fritters**

### **Ingredients**

Ripe jack fruit - 200 g  
Maida - 50 g  
Corn flour - 25 g



Sugar - 1 tea spoon

Sesame seeds - tea spoon

Cardamom powder - ¼ tea spoon

Salt - to taste

Oil - 200 ml

### **Method**

- = Cut ripe jackfruit bulbs into broad pieces.
- = Mix all the ingredients except oil into a thick batter.
- = Dip the jackfruit pieces in the batter.
- = Fry in the oil till golden brown and serve

## **Jackfruit squash**

### **Ingredients**

Well ripened jackfruit bulbs - 1 kg  
Pineapple - 1 No.  
Sugar - 3/4 cup  
Water - 100 to 150 ml  
Citric acid - 1 teaspoon

### **Method**

- = Cut open well ripe jackfruit. Remove bulbs and extract out the seeds.
- = Cut the well ripe bulbs into small cubes.



- = Boil 1 kg of pieces in water and then pulp into fine paste.
- = Take 1 part of pulp, add water and mix thoroughly using mixer.
- = Extract juice from pineapple and add to jack pulp in 0.5: 1 ratio.
- = Prepare sugar syrup by boiling 250 g of sugar in 250 ml of water.
- = Add sugar syrup to jackfruit pulp followed by citric acid.
- = Add 700 mg of Potassium Meta bisulphite for 1 litre of squash.
- = Cool and fill in glass bottles.

### **Jackfruit jam**

#### **Ingredients**

Well ripened jackfruit - 500 g

Sugar - 350 g

Citric acid - 1 teaspoon

Water - as required

#### **Method**

- = Cut the well ripe jackfruit into small pieces
- = Boil the pieces with water and pulp into fine paste



- = Add the jackfruit paste and sugar and cook on pan with little water, if required
- = Add permitted food colour and citric acid to the mixture. Add one tablespoon of lime juice to the same (optional).
- = Stir continuously till jam consistency
- = Test for end point using ladle test.

### **Jackfruit leather**

#### **Ingredients**

Well ripened jackfruit - 500 g

#### **Method**

- = Cut the well ripened jack fruit into small pieces
- = Pulp into fine paste
- = Spread the smooth pulp as uniform layer on trays
- = Dry using solar or electric cabinet drier. The leather can also be dried under direct sun light in plates or trays. It is dried till moisture is lost and starts coming out of the tray. If dried beyond this, it becomes brittle.
- = After drying, cut into desired size and shape and pack in polythene pouches



## ***Jackfruit chocolate***

### ***Ingredients***

Jackfruit pulp - 1 kg

Sugar - 500 g

Milk powder - 150 g

Butter - 100 g

Cocoa powder - 50 g

### ***Method***

- Cut the well ripened jack fruit into small pieces
- Pulp into fine paste
- Mix jackfruit pulp and sugar in a heavy bottom pan.
- Cook on flame till it reduces to 1/3rd volume
- Then add milk powder dissolved in 100 ml of hot water, followed by ghee and cocoa powder mixed in hot water.
- Mix well and stir on low fire till desirable consistency. One should be able to make balls by rolling on palm.
- Pour the mixture in a plate and roll it into chocolates
- Refrigerate for 2hrs and then pack individually in butter paper.

*Courtesy: Jackfruit festival, Sirsi, May 2013.*



## ***Jack seed Burfi***

### ***Ingredients***

Jackfruit seeds - 25-30 no

Maida - 100 g

Gram flour - 150 g

Milk - 200 ml

Sugar - 500 g

Butter - 150 g

Vanilla essence - 1 tea spoon

Cardamom powder - ¼ tea spoon

Pista crushed - 1 table spoon

### ***Method***

- Cut open well ripe jackfruit. Remove bulbs and extract out the seeds.
- Boil the jack fruit seeds till they are cooked.
- Remove seed coat manually, cut in to small pieces and make a smooth paste using a mixer
- Add maida, gram flour and sugar to milk and mix well
- Into a pan add paste of jackfruit seed and the milk mixture and mix thoroughly



- Keep on the fire and keep on stirring till it becomes hard and roll into a ball in the hand
- Keep adding butter in small quantities while stirring
- Towards the end add vanilla essence, cardamom powder and pista
- When done pour the mixture into a greased pan. When cool cut into pieces

*Courtesy: [www.showmeth Curry.com](http://www.showmeth Curry.com)*

### ***Jack seed pakodas***

Well matured jackfruit seeds - 500 g

Onions - 3 Nos.

Green chilli - 8 Nos.

Coriander leaves - half bunch

Curry leaves - 2-3 sprigs

Gram flour - 50 g

Chilli powder - 2 teaspoon

Salt - to taste

Oil - 500 ml



### ***Method***

- Boil the jackfruit seed
- Remove seed coat, cut in to small pieces and make powder in a mixer
- Add chopped onion, green chilli, curry leaves and coriander leaves.
- Add gram flour, salt and chilli powder to the above; mix well by adding water till required consistency.
- Make small to medium sized balls and deep fry in oil





## OSMOTIC DEHYDRATION

Jackfruit is grown in Southern States (Kerala, Tamil Nadu and Karnataka). The fruits are available during March to August. A large proportion of fruits are being lost through spoilage.

Ripe fruits are used for nectar and jams. Unripe fruits are also used for culinary preparations like chips, pickles, etc. Traditionally jackfruit is processed into various products such as jam, papad, chips, squash, varatty, jack leather etc.,

If we look at Jackfruit on consumer point of view, a section of people who like to eat the fruit but feel difficulty as the fruit is too big and cutting and scooping out the edible portion is cumbersome.

Therefore, osmotically dehydrated jackfruit slices will be very handy for consumers. The edible portion in the form of fresh bulbs after pitting is approximately 30–35 per cent of the whole fruit and after osmotic dehydration there will be further 1/3rd reduction in weight as compared to fresh bulbs. Therefore, transportation and packaging costs can be very well reduced. This will not only help the farmers to utilize the perishable raw material but also generate more employment opportunities in rural areas. Processing of jackfruit bulbs into osmotically dehydrated slices is one such



option as the technology is very well suited for small scale processing in rural areas.

Osmo-air dried fruits are the dehydrated fruit products based on the novel approach towards dehydration. First stage in osmotic dehydration is removal of water using concentrated osmotic medium ( sugar syrup) followed by dehydration of osmosed slices using hot air drier to a moisture content of 15 per cent. The quality of osmotically dehydrated product is near to the fresh fruit in terms of colour, flavour and texture. It can be consumed as a snack. Such product can be used as to eat foods, can be an ingredient in ice creams, fruit salad, kheer, cakes, bakery products etc.

Process: Suitable fruits are selected at optimum stage of ripeness (hard ripe stage), bulbs are extracted and made into slices followed by dipping in sugar syrup (50-70° Brix) containing citric acid and preservatives and with and without maltodextrin. After immersion time slices are drained and dried in cabinet dryer at 50-60°C temp till moisture content reaches around 15 per cent. Dried slices are packed in plastic punnets and can be stored at RT for one year. About 12-13 kg of fresh fruits is needed to make one kg of osmotically dehydrated slices.

Uses: The product can be used alone as dried fruit (snack) or as a adjuvant with other dried fruits like dates, cashew,



almond etc. it can also be used in ice-cream industry, confectionary, fruit salads, kheer, cakes and bakery products. This is highly suitable for children, mountaineers, defense forces in difficult areas where carrying and delivering bulky and perishable fresh fruits is difficult.



Osmotically dehydrated slices from Yellow and Orange Jack fruit



## MECHANISATION - MINIMAL PROCESSING

Jackfruit is relished not only for its ripe fruits but also for its raw tender fruit is used for culinary purpose. However, though all sections of the society like to consume raw jackfruit, it is not very popular due to the cumbersome process of peeling the latex filled skin of the jackfruit. Odisha having lot of area under jackfruit trees hence has a lot of potential for ready to cook (RTC) tender jackfruit. Recognising this potential of jackfruit processing, Central Horticultural Experiment Station, Bhubaneswar has identified a mechanical peeling process of the tender jackfruits and its post harvest treatment for longer shelf life and colour retention identified machine further revalidation in process.

The minimal processing of the jackfruit involves mechanical peeling of the skin using modified wood planer. This process hastens the process of peeling by five times as compared to the manual traditional peeling by using knife. The mechanical peeling could not only reduce the drudgery involved in the manual peeling but also saved lot of time. Further, protocols for cutting and processing of the small jackfruit pieces have also been standardised. Dipping of small pieces in solution of 1% citric acid prevents the browning of the tender jackfruit for one week. The jack fruit pieces packed in the poly-bags are highly appealing to the consum-



ers. This model of minimal processing of tender jackfruit for developing marketable RTC packets has been taken up as one of the interventions under Tribal Sub Plan in tribal villages Mohna block of Gajapati district is highly successful. The tribal women are able to process more quantities of jackfruits and market in the nearby towns.



Ready to cook minimally processed raw jack fruit



Tribal Women self help group involved in minimal processing of raw jack fruit



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