





PM Formalisation of Micro Food Processing Enterprises Scheme

Processing of Jack Fruit Chips



AATMANIRBHAR BHARAT

National Institute of Food Technology, Entrepreneurship and Management (NIFTEM) - Thanjavur

(an Institute of National Importance under Ministry of Food Processing Industries, Government of India) Pudukkottai Road, Thanajvur – 613005 <u>https://niftem-t.ac.in/</u> Ph : 04362-228155, Fax:04632-227971

TABLE OF CONTENTS

Page No.

Chapter 1: Introduction	
1.1 Status and Market size	1
1.1.1. Socioeconomic significance	2
1.1.2. Cultivation Scenario	4
1.1.3. Production status of Jackfruit	5
1.1.4. Production and yield of Jackfruit in major states in India	6
1.1.5. Composition & Nutritive Value of Jackfruit	7
1.1.6. Health benefits of Jackfruit	9
1.1.7. Nutraceutical properties of Jackfruit	10
1.2 Indian Market Outlook	13
1.3 Value added products from Jackfruit	13
1.3.1 Jackfruit Chips	14
Chapter 2: Processing of Jackfruit Chips	
2.1 Process flow for production of Jackfruit Chips	17
2.1.1 Fruit selection	17
2.1.2 Washing	18
2.1.3 Peeling & De-seeding	18
2.1.4 Slicing	18
2.1.5 Blanching & draining	18
2.1.6 Drying	18
2.1.7 Frying	19
2.1.8 Salting & packing	20
2.2. Modern Technology	20
2.2.1 Mechanized Raw Jackfruit peeler	20
2.2.2 Jackfruit Slicer	21
2.2.3 Blancher cum Dryer	22
2.2.4 Vacuum Fryer	22
Chapter 3: Packaging of Jackfruit Chips	
3.1 Packaging requirements of Jack fruit chips	24
3.2 Packaging Materials for Jack Fruit Chips	25
Chapter 4: Food Safety Regulations and Standards	
Machineries Manufacturers & Suppliers	29

CHAPTER 1

INTRODUCTION

1.1. Status and Market Size

Jackfruit is a tropical fruit species found in tropical, high rainfall, coastal and humid areas of the world. It belongs to family Moraceae. Scientifically known as Artocarpus heterophyllus, it is the favourite fruit of many owing to its sweetness.

Jackfruit is indigenous to the rain forests of the Western Ghats of India and is cultivated throughout the tropical lowlands in South and Southeast Asia, parts of central and eastern Africa and Brazil. It is a popular and relatively cheaper fruit in Southern Asia and other warm countries of both the hemispheres. In Europe, the fruit is sold canned with sugar syrup.

Away from the Far East, the jackfruit has never gained widespread acceptance; this is largely due to the odour of the ripe fruit. Jackfruit is the largest tree-borne fruit in the world, reaching up to 50 kg in weight and 60-90 cm in length. A mature tree produces up to 700 fruits per year, each weighing 0.5 to 50 kg. On an average, 50- 80 tons of fruits can be harvested from a hectare of land.

This family encompasses about 1,000 species in 67 genera, mostly tropical shrubs and trees, but also a few vines and herbs. The word Artocarpus is derived from the Greek words artos (bread) and carpos (fruit). The name "Jackfruit" is derived from the Portuguese jaca, which in turn, is derived from the Malayalam language term, chakka. The fruit is popularly known as, kathal or kata-hai in Bengali and in Hindi. The Malayalam name chakka was recorded by Hendrikl van Rheede (1678-1703) in the Hortus Malabaricus, vol. iii in Latin.

In our country, the trees are found distributed in southern states like Kerala, Tamil Nadu, Karnataka, Goa, coastal Maharashtra and other states like, Assam, Bihar, Tripura, Uttar Pradesh and foothills of Himalayas.

Apart from its use as a table fruit, jack is a popular fruit for preparation of pickles, chips, jack leather and papad. The fruit has got good potential for value addition into several products like squash, jam, candy, halwa etc. The ripe bulbs can be preserved for one year in sugar syrup or in the form of sweetened pulp. The unripe mature bulbs can be blanched and dehydrated for further use throughout the year. Seed is a rich source of starch and a delicacy during season. The timber is highly

valued for its strength and sought for construction and furniture. The dried leaves are stitched to make disposable plates.

1.1.1. Socioeconomic importance

Jackfruit does not spread readily and is not considered invasive species. In most areas of the world where jackfruit is grown, its presence is indicative of human cultivation. Jackfruit was introduced to most Pacific Islands, 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 like the breadfruit (A. altilis). All parts of the tree have been reported to have medicinal properties. The Chinese consider jackfruit pulp and seeds as tonic, cooling and nutritious, and to be useful in overcoming the influence of alcohol on the system. The seed starch is given to a person to relieve biliousness and the roasted seeds are regarded as aphrodisiac. The ash of jackfruit leaves if mixed with corn and coconut shell ash is used alone or mixed with coconut oil to heal ulcers. The dried latex yields artostenone, a compound that is convertible to artosterone, which has a potent androgenic property (having male hormone activity). If mixed with vinegar, the latex promotes healing of abscesses. The root is a remedy for skin diseases and asthma. An extract of the root is taken and used as cure for fever and diarrhoea. The bark is made into poultices. Heated leaves are placed on wounds. The wood has a sedative property; its pith is reported to induce abortion. Aside from flavouring for beverages, the fruit can be fermented and distilled to produce alcoholic liquor.

Country	Cultivars/varieties	Distinguishingcharacters
Sri Lanka	Father Long	Oblong, large size fruits (10-15 kg), perianth is attractive dark yellow colour, thick crispy and sweet in taste
	Maharagama	Oblong, large size fruits (10-15 kg), perianth is yellowish orange, crispy and sweet
	Kothmale	Oblong, large fruits (10-15 kg), large perianth, yellowish orange, crispy and sweet
Hirosa (Rosa Kos) Oblong, large fruit, larg crispy and sweet		Oblong, large fruit, large perianth, yellowish orange, crispy and sweet
	Mandoor	Round medium size fruit (8-10 kg), large perianth, dark yellow colour, crispy and sweet

Table 1: Different jackfruit cultivars in the world

Indonesia	Nangkamerah	Red orange (merah)colour	
	Nangkasalak	Thick fruit flesh, soft, strong flavour, fruit flesh is similar to salacca fruit	
	Nangka durian	Fruit flesh is similar to durian	
	Nangkacempedak	Thin flesh fruit, having good and specific flavor	
	Nangkaburbur	Thin fruit flesh, soft, strong flavor	
	Red nangka mini/ round nangka mini	Mini jackfruit	
	Nangkakunir	Officially released as a national superior variety	
	Tabouey	Fruit round, flesh yellow, firm, pleasant flavor and very little aroma	
Philippines	Sinapelo	Fruit is oblong, average fruit weight10 kg, flesh is yellow orange, firm and very sweet	
	Cervantes Gold	Fruit is ellipsoid, average fruit weight 10 kg, flesh is golden yellow, sweet, crispy with strong aroma	
	EVIARC Sweet	Fruit is ovoid, average fruit weight 12 kg, flesh is golden yellow, sweet (25 °B), crispy with strong aroma	
	MMSU SRO	Fruit is ellipsoid, average fruit weight 8 kg, flesh is yellow orange, very sweet (30°B), firm with mild aroma	
	Mabini	Fruit is oblong, average fruit weight 15 kg, flesh is yellow orange, sweet (20.4 °B) with strong aroma	
Malaysia J2 Fless slig life		Flesh taste sweet with a ting of acid and is slightly fibrous, moderate aroma and poor shelf life	
	J27	Medium size fruit, thick fleshed, orange in colour, sweet taste	
	J28	Thick flesh, golden yellow in colour, sweet taste	
	J29	Medium to large fruit, round in shape, pulp yellow, thick, sweet and good for fresh consumption	
	J30	Elongate fruit, flesh yellow, thick, sweet with a moderate aroma	
	J31	Yellow flesh, medium thick, crispy, sweet,	

		strong aroma with fine texture, dual purpose, suitable for canning	
	Black Gold Pulp deep orange, soft, sweet and aromatic		
	Cheena Pulp deep orange, soft, excellent quality and v aromatic		
	Cochin	Pulp yellow to orange, firm, quality good and mild aroma	
	Chompa Gob	ompa Gob Flaks orange, firm, mild flavour	
	Golden Nugget	Flaks deep orange, soft to medium firm, excellent flavour	
	Lemon Gold	Flaks lemon yellow, firm, sweet and aromatic flavor	
Bangladesh	Topa, Hazari, Chala, Goal, Koa, Khaja		
Myanmar	Talaing, Kala		

1.1.2. Cultivation Scenario

The benefit of cultivation of the jackfruit depends upon whether it is grown in the homestead as a backyard crop or as a plantation crop. Establishment of a jackfruit plantation requires a large investment such as the nursery establishment, proper management of the crop, etc. However, during the first 3-4 years, other crops such as pineapple or vegetables can be grown which will cover the cost of maintaining the jackfruit plants.

Jackfruit plays a significant role in Indian agriculture and culture. It was cultivated in India 3,000-6,000 years ago. Jackfruit is widely grown as an important tree in Kerala's homesteads and also as a shade crop in coffee plantations. It is popularly known as poor man's fruit in the eastern and southern parts of India. The tender fruits of the tree are used as vegetables and the ripe ones as table fruits.

The traditional varieties bear fruits once in a year. Usually, the flowering starts from mid-November and extends till mid-February, depending on the location and the variety. The tender fruits come to market from March onwards and continue till August. The fruits begin to ripe in the month of June. However, the late varieties may ripen in October. Fresh and tender fruits are usually not available from November onwards.

Commercial cultivation of jackfruit is still at a primitive stage in India, primarily because of the difficulty in procuring elite planting materials. Jack is easily propagated through seeds. The seedlings take 8-10 years to bear fruits. Due to the highly cross pollinated nature of the crop, vegetative propagation is essential in order to get true to type plants.

Since jackfruit is very bulky and perishable, processing can reduce transport costs, prevent spoilage, increase shelf life. Processed products usually command higher prices especially during the off-peak season. If the farmers can form cooperatives and arrange cold storage facilities, they can increase their profits by storing the produce during the peak season and then sell the fruits during the off-peak season.

1.1.3. Production status of Jackfruit

Major jackfruit producers are Bangladesh, India, Myanmar, Thailand, Vietnam, China, the Philippines, Indonesia, Malaysia and Sri Lanka.

Country	Area	Production	Productivity
	('000 ha)	('000 t)	(t/ha)
Bangladesh	10.00 (2006)	926.00	8.20
India	102.00 (1992)	1436.00	11.40
Indonesia	50.00 (1987)	340.00	9.00
Malaysia	5.00 (1987)	13.00	10.00
Nepal	1.60 (2009-10)	18.97	11.89
	2.17 (2002-03)	17.16	11.60
Sri Lanka	50.00 (2011)	*	*
Thailand	37.00 (1987)	392.00	10.00

Table 2: Area, production and productivity of jackfruit in Asia

1.1.4. Production and yield of Jackfruit in major states in India

India is the second biggest producer of the fruit in the world and is considered as the motherland of jackfruit. Chakka, its Malayalam name, according to some, has given birth to the English name jackfruit.

In India, the total area under jackfruit cultivation is approximately 1,02,552 hectares, of which, an estimated 1,00,000 trees are grown in back yards and as intercrop in other commercial crops (betel nut, coffee, pepper and cardamom plantations) in south India. In India, it has wide distribution in Assam, Tripura, Bihar, Uttar Pradesh, the foothills of the Himalayas and South Indian States of Kerala, Tamil Nadu and Karnataka.

In India, the major area under jackfruit is in Kerala state and it was regarded as heavenly fruit in the ancient periods. It is grown in an area of 97,536 ha with annual production of 348 million fruits and productivity of 3,568 fruits per ha. The region comprising Assam and Tripura produces major share of jackfruit in India and the total annual production in Assam is estimated to be in the vicinity of 1,75,000 tons. In Assam, though the area and production has not shown any change, but the productivity has been improving. The value of jackfruit in Karnataka has been calculated at Rs.12,718 lakhs.

States	Area (000' ha)	Production (000' MT)	Productivity (tonnes/ha)	Year
Arunachal Pradesh	1.06	8.52	8.03	2005
Jharkhand	4.10	41.00	10.01	2008
Karnataka	6.78	231.57	34.17	2005
West Bengal	10.42	143.47	13.76	2005
Kerala	97.54	348	9.49	2010
Assam	18.00			2003-04

Table 3: Area, production and productivity of jackfruit in Indian states

Source: Horticultural Crop statistics

1.1.5. Composition & Nutritive Value of Jackfruit

Nutrients	Young fruit	Ripe fruit	Seed
Water (g)	76.2-85.2	72.0-94.0	51.0-64.5
Protein (g)	2.0-2.6	1.2-1.9	6.6-7.04
Fat (g)	0.1-0.6	0.1-0.4	0.40-0.43
Carbohydrate (g)	9.4-11.5	16.0-25.4	25.8-38.4
Fibre (g)	2.6-3.6	1.0-1.5	1.0-1.5
Total sugars (g)		20.6	
Total minerals (g)	0.9	0.8-0.9	0.9-1.2
Calcium (mg)	30.0-73.2	20.0-37.0	50.0
Magnesium (mg)	NA*	27.0	54.0
Phosphorus (mg)	20.0-57.2	38.0-41.0	38.0-97.0
Potassium (mg)	287.0-323.0	191.0-407.0	246.0
Sodium (mg)	3.0-35.0	2.0-41.0	63.2
Iron (mg)	0.4-1.9	0.5-1.1	1.5
Vitamin A (IU)	30.0	175.0-540.0	10.0-17.0
Thiamine (mg)	0.05-0.15	0.03-0.09	0.25
Riboflavin (mg)	0.05-0.2	0.05-0.4	0.11-0.3
Vitamin C (mg)	12.0-14.0	7.0-10.0	11.0
Energy (Kj)	50-210	88-410	133-139

Table 4: Composition of jackfruit (100 g edible portion), fresh weight basis

Nutrients	Nutrient value	RDA (%)
Cholesterol (mg)	0	0
Dietary fiber (g)	1.5	4.0
Vitamins		
Folate (µg)	24.0	6.0
Niacin (mg)	0.920	6.0
Pyridoxine (mg)	0.329	25.0
Riboflavin (mg)	0.055	4.0
Thiamin (mg)	0.105	9.0
Vitamin A (IU)	110.0	3.5
Vitamin C (mg)	13.7	23.0
Vitamin E (mg)	0.34	2.0
Electrolytes		
Sodium (mg)	3.0	0
Potassium (mg)	303.0	6.5
Minerals		
Calcium (mg)	34.0	3.4
Iron (mg)	0.60	7.5
Magnesium (mg)	37.0	9.0
Manganese (mg)	0.197	8.5
Phosphorus (mg)	36.0	5.0
Phosphorus (mg)	21.0	3.0
Selenium (mg)	0.6	1.0
Zinc (mg)	0.42	4.0
Phytonutrients		
Carotene-ß (µg)	61.0	*
Crypto- xanthin-ß (µg)	5.0	*
Lutein- zeaxanthin (µg)	157.0	*

Table 5: Nutritive value jackfruit (per 100 g)

Source: USDA National Nutrient Database

*No Recommended RDA for phytonutrients

1.1.6. Health benefits of Jackfruit

• Strengthens Immune System

Jackfruit is an excellent source of vitamin C, which helps to protect against viral and bacterial infections. Vitamin C helps to strengthen the immune system function by supporting the white blood cells function. One cup of jackfruit can supply the body with a very good amount of this powerful antioxidant.

• Protects against Cancer

In addition to containing vitamin C, jackfruit is also rich in phyto-nutrients such as lignants, lisoflavones and saponin which have anti cancer and anti aging properties. These phyto-nutrients may help eliminate cancer causing free radicals from the body and slow the degeneration of cells that can lead to degenerative diseases

• Aids in healthy digestion

Jackfruit is also known to contain anti ulcer properties which help cure ulcers and digestive disorders. In addition, the presence of high fiber in the jackfruit prevents constipation and helps in smooth bowel movements. These fibers also offer protection to mucous membrane by driving away the carcinogenic chemicals from the large intestine.

• Maintains healthy eye and skin

Jackfruit contains vitamin A, a powerful nutrient which is known to maintain a healthy eye and skin. It also helps prevent vision related problems such as macular degeneration and night blindness

Boosts Energy

Jackfruit is considered as an energy generating fruit due to the presence of simple sugars like fructose and sucrose which give you an almost immediate energy boost. Although Jackfruit is an energy rich fruit it contains no saturated fatty oil and cholesterol making it a healthy fruit to savour.

• Lowers blood pressure

Potassium contained in Jackfruit has been found to be helpful in the lowering of blood pressure and thus reducing the risk of heart attack as well as strokes.

Controls Asthma

The root of jackfruit has been found to help those who suffer from asthma. Extract of boiled jackfruit root has been found to control asthma

• Strengthens bones

Jackfruit is rich in magnesium a nutrient which is important in the absorption of calcium and works with calcium to help strengthen the bone and prevent bone related disorders such as osteoporosis

• Prevents Anemia

Jackfruit also contains iron which helps to prevent anaemia and also helps in proper blood circulation in our body

• Maintains Thyroid health

Jackfruit is loaded with Copper, an important mineral, which plays a key role in the thyroid metabolism, especially in hormone production and absorption.

1.1.7. Nutraceutical properties of Jackfruit

Anticancer properties

Phytonutrients in jackfruit bulbs have anticancer properties. The main role of these nutrients is to help prevent the harmful free radicals that have been known to develop cancer and many other chronic diseases. The phytonutrients prevent the very initial stage of cancer cell formation. Saponins are also strong anticancer agents. Saponins show colon cancer preventative properties. These phytonutrients have been found to induce mitotic arrest in the case of leukemia cells. The study also found that it helped in some cases to cause remission. Saponins were found to react to the outer layers of cancer cells. They bound the cells and prevented their further growth.

Jackfruit is rich in fiber. It also has a unique sticky form. Both these properties combine together to work as a great colon cleanser. It helps in removing toxins from digestive tract. This further helps in reducing the risk of colon cancer.

Diabetic supportive

The extract of jackfruit improves the glucose tolerance in normal human subjects and diabetic patients. Jackfruit contains vitamin A, vitamin C, thiamin, riboflavin, niacin, calcium, potassium, iron, manganese and magnesium among many other nutrients. It is good for diabetes as they improve insulin resistance. Consuming 100g of the jack fruit meal per day for 4 months leads to quantitative reduction in fasting blood glucose (FBG), postprandial blood glucose (PBG), and hemoglobin A1c (HbA1c) compared with the baseline. The HbA1c decreased by 13.59%, FBG by 22.68%, and PBG by 25.69%. They have concluded that the dietary supplementation of the jack fruit raw fruit meal preparation has an impact in reducing type 2diabetes.

Jackfruit has beneficial nutritional parameters and a low GI. This could be due to the collective contributions of dietary fiber, slowly available glucose, intact starch granules in seeds and influence of different sources of carbohydrates.

Immune System supportive

Jacalin, the major protein from the Artocarpus heterophyllus seeds, is a tetrameric twochainlectincombiningaheavychainof133aminoacidresidueswithalightß chain of 20-21 amino acid residues. Jacalin's uniqueness in being strongly mitogenic for human CD4 + Т lymphocytes has made it а useful tool for the evaluationoftheimmunestatusofpatientsinfectedwithhumanimmunodeficiency virus HIV-1.

Digestion promotive

The presence of high fiber (3.6 g/100 g) in the jackfruit prevents constipation and helps in smooth bowel movements. These fibers also offer protection against colon mucous membrane by removing or driving away the carcinogenic.

Cardiovascularsupportive

One of the major risk factors for the development of coronary heart disease is dyslipidemia, which is mainly characterized by elevated levels of low-density lipoprotein cholesterol(LDL-C) and/ or reduced high-density lipoprotein cholesterol (HDL-C).Jackfruit seeds may help reduce levels of low-density lipoprotein (LDL) cholesterol and raise levels of high-density lipoprotein (HDL) cholesterol.

Fast-Dissolving Tablets

Themajorstoragecarbohydrateinplantsisstarch.Theannualworld-wideproduction of starch is 66.5million tons (FAOSTAT).Growing demand for starches in the industry has created interest in new sources of this polysaccharide, such as leaves, legume seeds, and fruits. It has immense industrial use in the manufacture of products such as food, textile, paper, adhesives, and pharmaceuticals. Starch can also serve as a thickening, gelling, and film-forming properties.

Jackfruit seed cotyledons are fairly rich in starch and protein. The recent investigation shows that the jackfruit seed starch has potential in pharmaceutical industries. The starches extracted from jackfruit seeds are used as super disintegrants for the formulation of fast-dissolving tablets (FDT).

Antimicrobial properties

Jackfruit is well known to have antibacterial property against 24 species of bacteria. A jackfruit lectin, i.e., jacalin, inhibits DNA viruses such as herpes simplex virus type II (HSV-2), varicella-zoster virus (VZV), and cytomegalovirus (CMV) The jackfruit could be considered a functional food because it has valuable compounds indifferent parts of the fruit that display functional and medicinal effects.

'Functional foods' are those that provide more than simple nutrition; they supply additional physiological benefits to the consumer. Because dietary habits are specific to populations and vary widely, it is necessary to study the disease- preventive potential of functional micronutrients in the regional diets.

Dental Health promotive

In jackfruit tree, latex or resin are found on the trunk of tree as well as the fruit. All parts of jackfruit tree contain sticky white latex which produced from special secretory cells called laticifers. Latex is an aqueous emulsion containing many ingredients, for instance, lipids, rubbers, resins, sugars, and proteins including proteolytic enzymes The jackfruit latex extract which is rich in flavonoids and alkaloids was checked for antibacterial and antifungal properties which shows fairly well and significant in comparison with standard antibacterial and antifungal drugs. They concluded that

this information gives about the several important uses of jackfruit latex or resin, or both can be utilized as the cementing medium, irrigation solution (washing of a body cavity or wound by a stream of fluid), denture cleaning solution, resin, and other future dental filling material in terms of cost-effectiveness.

1.2. Indian Market Outlook

The jackfruit is still an underdog in the Indian scenario. However, the fruit is perishable and cannot be stored for long time because of its inherent compositional and textural characteristics. In every year, a considerable amount of jackfruit, specially obtained in the glut season (June-July) goes waste due to lack of proper postharvest knowledge during harvesting, transporting and storing both in quality and quantity. It is reported that almost Rs 2,000 crore value of Jackfruit goes to waste annually in the country. According to some resources, Kerala state wastes approximately 35 crore jackfruits every year.

Value addition is still a new concept and the market penetration of value added products is not much due to lack of awareness and handling difficulties. An assessment of the market scenario shows that the demand is more in the northern, southern and western parts of the country and there is also a substantial scope I the export market especially to UK, Middle East and the USA.

The potential for value added products provides an extremely viable opportunity for sustainable promotion of rural as well as urban livelihoods. Processing of jackfruits into various value added products at small scale/ village level and selling to the markets directly/ tying up with big aggregators will help both the farmers and the consumers.

Proper postharvest technology for prolonging shelf life is, therefore, necessary. Besides, alternate ways of using jackfruits in on-season plays significant roles in reducing postharvest losses. Among them, processing is important one. It adds diversified and attractive food items in dietary menu as well as contributes to generation of income and employment.

1.3. Value added products from jack fruit

A number of products have been developed from raw, tender and ripe fruits and seeds. The ripe fruit bulbs (excluding seed) and the rind of the ripe fruit (including perianth and unfertilised flowers) have been used for processing in a number of products. Ripe jackfruit bulbs are canned in syrup, made into jams either pure or mixed with dehydrated bulbs, chutney, preserves, candy, and concentrate and powder. Rinds of ripe fruit are made into jelly. Dehydrated bulbs and dehydrated raw jackfruit flour are also in the market. Out of the several products, Jackfruit chips is a very significant and demanded product.

1.3.1. Jackfruit chips

Jackfruit chips are significant value added products of Jackfruit as frying is a quick process and produces a sterile and dry product with relatively longer shelf life.

Frying process is one of the oldest cooking methods and most widely practiced in the world. Frying process is considered as a dry cooking method because it does not involve water. In the frying process, oil conduction occurred at high temperature presses water out of food in the form of bubbles. Fried foods last longer due to reduced water contents leading to less decomposition by microbes; even fried foods have enhanced nutritional value and sensory appeal.

Alternatively, Vacuum frying of fruits enables frying at lower temperatures compared to atmospheric frying, thereby improving quality attributes of the fried product, such as oil content, texture, retention of nutrients, and color.

Factors influencing dried fruit product quality are as follows

- Type of equipment
- Fruit type
- Pre-treatments such as blanching, hot air/ osmotic drying, freezing, antibrowning agents, and hydrocolloid application
- Processing conditions namely frying time, temperature, and vacuum pressure, has to be adjusted to the fruit characteristics.
- Fruit matrix properties including physical and chemical, which change during ripening

Varieties and stage of harvest

The varieties used for making chips have high dry matter content, as it directly impacts the product quality.

In South India, the jackfruit is classified into two general types:

Type 1 jackfruit having firm flesh is called Varikka is more important commercially and possesses crispy carpels/flakes of high quality. The Varikka variety is used both in the raw (unripe) and ripe stages. If used in the unripe stage, it is usually made into curries and deep-fried chips.

Type 2 jackfruit has soft flesh and is called Koozha. They have small fruits whose flesh is fibrous, soft, mushy, but it has very sweet carpels/ flakes. The fruit of the Koozha variety is consumed mainly in the raw stage like preparing pickles or cooking different vegetable dishes.

Fruits in the stage IV and stage V of ripening are usually preferred for chips making.

Stage IV: Seeds and fruitlets are fully developed. This stage is ideal for making chips and for use in different food preparations like curries.

Stage V: Fully mature fruits are utilized for making chips and used for preparing different vegetable dishes.

A dull, hollow sound when the fruit is tapped is considered to be the most reliable indicator that the fruit is already mature. Harvesting at this stage permits the fruit to be used for making chips.

CHAPTER 2

Processing of Jackfruit Chips

In recent years, snack food industry has emerged as one of the important sectors for the modern consumers with a special desire for fried snack foods. Fried products are liked by all age groups and play an important role in consumer's diet because of their unique flavour and texture. Frying is a quick process which leads to a sterile and dry product with relatively longer shelf life. During the frying process, food is immersed in an oil bath at a temperature above the boiling point of water which results in counter flow of water vapor and oil at the surface of the product. Food frying technology can extend the shelf life of fruits and vegetables.

The pre and post-processing steps are critical to reduce the frying load as well as to make better quality product. The common methods used for pre-treatment are blanching, salting, soaking and drying, while post-processing such as coating, blending, packaging, etc. are also important after frying of food

While the frying oil is used to enhance the flavor of the products, the use of improper frying oil can have harmful effects on human health.Oil uptake is one of the most important quality parameters of fried food. Oil consumption poses significant health problems such as coronary heart diseases, cancer, diabetes, and hypertension and is irreconcilable with consumers' awareness towards the consumption of healthier and low fat food products. Degradation of important nutritional compounds and the generation of toxic molecules in the foodstuff due to high frying temperatures and exposure to oxygen have led to the development of healthy and low fat snack products.

2.1. Process flow for production of Jackfruit Chips



2.1.1. Fruit selection

Whole jackfruits of firm variety, with an average weight of 8-10 kg, devoid of any visible microbial infection or mechanical fissures with proper maturity should be selected. A dull, hollow sound when the fruit is tapped is considered to be the most reliable indicator that the fruit is already mature. Varieties with high dry matter content should be selected, as it directly impacts the product quality.

2.1.2. Washing

Fully mature jackfruits are taken and washed with clean water properly to remove the external impurities. The fruits' surface can be sanitized with 100 ppm chlorinated water.

2.1.3. Peeling & De-seeding

Peeling is then done carefully. The edible perianth portion (bulbs) are separated manually by slitting open the fruit using stainless steel knives. The bulbs were given a vertical cut to remove the seed.

2.1.4. Slicing

The pitted bulbs are cut vertically into uniform 4cm X 2 cm slices, manually or using a slicer. The manual method using knives is unhygienic and does not produce chips of uniform thickness and may cause injury to the persons while slicing. So mechanical slicers are preferable; they can minimize loss of material and can do trouble free-slicing at higher quality and better efficiency than manual slicing. The manual labourand drudgery can be eliminated.

The sliced bulbs can be subjected to wash in 30 ppm chlorinated water.

2.1.5. Blanching& draining

Blanching is done to arrest the enzymatic activities before drying. Blanching also effectively reduces glucose concentrations in the slices and hence results in significantly lower acrylamide formation during frying. Blanching also significantly impacts the color and oil uptake of the end product positively.

The slices are weighed out and immersed in hot water at 90°C containing 0.1% KMS for 10-15 minutes. For every kg of sliced bulbs, 2 kg of blanching solution is needed. The blanched slices are cooled to room temperature, by immersing in cold water for 15 minutes; this is done to avoid cooking.

2.1.6. Drying

After sieving water, the slices are dried using a mechanical dryer in view to absorbing less oil in subsequent frying maintaining temperature 70°C for 1 hour and

60°C for the next 6 hours. Drying has a significant effect on the deep frying. Reducing the food moisture content by drying can reduce oil absorption during frying by up to 54%.

2.1.7. Frying

Frying is a complex operation process where the fruit slices are immersed in hot vegetable oil, at a temperature of above the boiling point of water. This condition causes high rates of heat transfer, so that water evaporates and an oil layer covers the product surface. The frying process should reduce the initial moisture content of dried slices (75%) to 4%, the ideal moisture content of freshly prepared fried chips.

The slices are fried in edible oil; coconut oil is used in Kerala, while any refined vegetable oil such as sunflower oil can be used. Preferably, the ratio of jackfruit slice to oil should be1:2.5 to 1:4.

The dried slices are dropped into oil at a temperature of 160-180°C and stirred with narrow wooden stick. When the chips transform to a light yellow colour, they are drained from the fry pan. At around 170°C, the required frying time is around 10 minutes.

However, it had been proven that frying under atmospheric conditions leads to loss of desirable colour and textural characteristic of the resulting products. This could be attributed to destruction of colour components of foods and excessive crust formation due to high frying temperatures. To resolve the problems due to high oil content leading to the immediate rancidity and the health problems due to the carcinogens produced during frying, vacuum frying can be adopted. The advantage of vacuum frying is that the oil quality gets maintained and the oil can be reused more than 50 times.

Vacuum frying happens under a negative pressure and low temperature that lowers the boiling points of the frying oil and water in the product, thereby the quality is retained. In vacuum frying, the frying happens at temperatures below 100°C. It is considered the best way to get high quality products, effectively cutting out oxygen- oil reaction at high temperatures which takes place during normal frying under atmospheric pressure conditions.

After frying, the jackfruit chips can be centrifuged at atmospheric pressure in a separate machine, to remove the excess oil.

2.1.8. Salting & packing

The prepared chips are mixed with salt and spices in a mixer. The mixture of salt and dry chilli powder at the ratio of 2:1 @ 8 gm/100 gm is usually added to the fried chips. After salting and spicing, the chips can be packed and stored.

2.2. Modern Technology

Traditional methods of jackfruit processing involve four major units operations namely peeling of fruits, cutting of fruits into slices, frying and packaging. Each of these unit operations are done manually especially due to the lack of appropriate mechanical system. These are generally done by human labour. These are tedious and required more time to complete the work. Inconsistent output, increased labour cost and delay in processing also an issue arise due to the lack of mechanization.

2.2.1. Mechanized Raw Jackfruit peeler

This is developed by the Indian Institute of Horticultural Research. The mechanised peeling of the skin using modified wood planer hastens the process of peeling by five times as compared to the manual traditional peeling by using knife. This hassle free and quick method of peeling can process 4-5 kg weighing jackfruit in less than five minutes. The mechanical peeling could not only reduce the drudgery involved in the manual peeling but also saved lot of time. The implement has two components like the peeling unit and the stainless steel box. The peeling unit is power operated. The box encloses the peeling unit and collects the peel scrapings. It is provided with bolt holes to secure it on a surface. The upper surface has the peeling base supported on SS square bars. The peeling base holds the peeling machine.



2.2.2. Jackfruit Slicer

The manual method of slicing jackfruit bulbs is unhygienic and does not produce chips of uniform thickness and may cause injury to the persons while slicing. But still the manual method of slicing is widely used due to the lack of efficient mechanical slicers. To fulfill these requirements a mechanical jackfruit slicer cum dicer was developed under Centre of Excellence in Post-harvest Technology at Kerala Agricul-

tural University. The slicer can be efficiently used in both small and large scale industries for slicing jackfruits with minimum loss of material (8.4%) and can do trouble free-slicing at higher quality and efficiency i.e., two to three times higher than manual slicing.

This machine can slice jackfruit bulbs into uniform sized slices. The machine requires only one person to operate. This machine has a capacity of 50 kg/hr and costs about Rs 50,000/-.



Slicer cum Dicer developed by the Post Harvest Technology Centre, Kerala Agricultural University

2.2.3. Blancher cum Dryer

Separate blanching and drying procedure is a time consuming and tedious process. It will also lead to increased production cost. Efficient drying with minimal time and operation cost is the main attraction of the newly developed blancher cum drier. The capacity of the blancher cum dryer unit is 18- 28 kg/ batch. Efficient drying and quality dried product can be produced by this combo machine. Approximate cost of the machine is Rs. 2,00,000/-. This machine is highly useful to micro and small scale jackfruit processing units for producing dried jackfruit flakes with minimum cost.



Blancher cum Dryer developed by the Post Harvest Technology Centre, Kerala Agricultural University

2.2.4. Vacuum fryer

It is an innovative and green technology for the production of healthy fried snack products. Currently the problem associated with the snack foods is its oil content that leading to the immediate rancidity and the health problems due to the carcinogen produced during frying. To resolve these problems a green technology was developed known as vacuum frying. The advantage of vacuum frying is that the oil quality gets maintained and the oil can be reused more than 50 times. The vacuum fried jackfruit can be stored for more than three months under active modified atmosphere packaging using nitrogen flushing. It is an innovative technology to conserve the oil degradation, reduce the oil absorption and retain the nutritional quality of the fried product by heating it under a negative pressure and low temperature that lowers the boiling points of the frying oil and water in the product.



Vacuum Fryer developed by the Post Harvest Technology Centre, Kerala Agricultural University

Vacuum fryers available in the market





CHAPTER 3 Packaging of Jackfruit Chips

Though snack food are categorised and perceived differently from region to region, by manufacturers and consumers, conventionally, snack food embrace a group of savoury, crispy items, which are ready-to-eat and are shelf stable for 2 to 16 weeks at the normal room temperature. These include deep fried potato chips, strips, sticks, rings etc. and represent a substantial share of the snack food market. Banana wafers, jack fruit chips, tapioca wafers, which are popular in South India, also fall into this group.

3.1. Packaging requirements of Jack fruit chips

a) Grease-proof nature

The presence of fat indicates that the main requirement of snack food packaging is that it should be grease-proof. This requirement is of significance not only in reducing the rancidity but also to prevent unsightly staining of the package, smudging of the printing and to avoid the actual seepage of the oil and the greasy package feel.

b) Rancidity

Another requirement due to the high fat content is the prevention of the product coming in contact with the oxygen in the air. A packaging material with low oxygen permeability is desirable to be used, to prevent oxidation and rancidity of fat.

c) Loss of crispness

One of the major properties of snacks is the crispness, which is achieved during the manufacture of the product by one of the drying methods such as roasting, baking or frying to reduce the level of moisture content. Retention of desirable texture (crispness) is directly related to the moisture level in the product. The moisture content of snack is very low, and any increase due to the hygroscopic nature of the product may lead to loss of crispness of the product. Moreover, added moisture also accelerates other biochemical changes such as oxidative rancidity. Low water vapour permeability of the package is, therefore, another very critical requirement.

d) Machinability

Some of the snacks have recently moved away from manual filling into preformed bags and are packed on automatic form-fill-seal machines which may run on fairly high speeds. Packaging materials must, therefore, be capable of running continuously and efficiently on these machines.

e) Physical strength

Due to the high fat content of the snack food products and the associated problem of rancidity, in some of the packages, where longer shelf-life is the requirement, oxygen inside the package may be replaced by an inert gas like nitrogen. The packaging material must be physically strong to withstand the processes of vacuumising/ gas flushing. The question of stiffness of the material is also debatable. It is desirable that the package should be able to stand up on the shelf, however, high stiffness leads to problems of machinability.

f) Printability

The packaging material should provide a good printing surface. Attractive printing is the order of the day as a number of brands of similar snack food have to compete in the market.

g) Seal integrity

To ensure protection against environmental conditions and to provide a long shelflife, the seal integrity of the pack must be good enough to prevent leakage and/or prevent entry of the air or moisture through the seal areas.

3.2. Packaging Materials for Jack Fruit Chips

1 Flexible Plastics

The overwhelming majority of snacks today are in flexible bags. For snack food in the Indian market, a range of flexible materials are used depending on the product and the market segment. Low value, typically traditional snack food and wafers may be branded or nonbranded. Non – branded snacks are packed for shorter shelf-life in unprinted low density polyethylene (LDPE) and polypropylene (PP) pouches. For branded snacks and nuts laminated structures are used.

Some of the typical structures are:

- BOPP / LDPE
- BOPP / Polyester / LDPE
- Metallised Polyester / LDPE
- BOPP / Metallised Polyester / LDPE
- Polyester / LDPE
- Polyester / Al foil / LDPE

2 Composite containers

Composite containers are used for packaging of moulded chips and nuts. The containers are round and the body (side walls) is made of PE coated foil laminated spirally wound paper. The top and bottom ends of the containers may be made from metal or plastic. The bottom may also be made from PE coated foil laminated paper. An aluminium pull-tab top and re-closable plastic lid on the container form a complete pack.

3 Tin plate containers

Rigid, round tinplate containers, which are internally lacquered are used for roasted salted nuts that are packed with an inert gas like nitrogen for extended shelf-life. The containers are provided with ring pull type, easy open tops, fitted with re-closable plastic caps.

4 Other packaging materials

Other types of plastic packages less commonly used for roasted salts nuts are PET containers and injection moulded PET or PP trays with peelable lids.

The pre-requisite to capture exports market for chips is to give a minimum shelf-life of 3 months. Since the chips has porous nature with very low bulk-density, the head space oxygen normally present in a unit pack is sufficient to cause oxidative rancidity and spoil the product. Further, the sharp edges of the product require puncture resistant packing material. Jackfruit chips can be packed in PE pouches/ HDPE pouches/ Aluminium foil laminates/ laminated polyester poly-pouches.

For better shelf life, packaging in laminated polyester pouches with nitrogen flushing or air tight containers can be done. Vacuum fried jackfruit chips can be stored for more than three months under active modified atmosphere packaging using nitrogen flushing.

CHAPTER 4

Food Safety Regulations & Standards

Snacks/ Savouries (Fried Products):- Chiwda, Bhujia, Dalmoth, Kadubale, Kharaboondi, Spiced & Fried dals, banana chips and similar fried products sold by any name

Additive	Name	Quantity
Antioxidants	Tocopherol	GMP
	Lecithin	GMP
	Butylated Hydroxyanisole (BHA)	200ppm max
	Tertiary butyl hydro quinone (TBHQ)	200 ppm max
Emulsifier/Stabiliser	Methyl cellulose	0.5% max
	Carboxy methyl cellulose	0.5% max
	Gellan gum	

Manufacturers List of Food Processing Machineries

S.no	Name of the company	Machineries
1.	Fry-Tech Food Equipments Private Limited	Fryer
	S. No. 4, Raviraj Industrial Estate,	
	Bhikhubhai Mukhi Ka Kuwa Bharwadvash,	
	Ramol, Ahmedabad - 380024,	
	Gujarat	
2.	Hindustan Vibrotech Pvt. Ltd.	Dryer
	Office No. 2, Ground Floor,	
	Vrindavan Building,	
	Vile Parle East,	
	Mumbai - 400057,	
	Maharashtra	
3.	Sakthi Automated Food Machines	Chips making
	Manufacturing Company	machine,
	Chinniyampalayam,	Cutting machine
	Coimbatore, Tamil Nadu	
	91-8048087399	
4.	Varaj Engineering, Pune, Maharashtra	Slicing machine
	YCM Hospital Road,Plot No 9/1,	
	General Block,Midc Bhosari,Near Midc	
	Corner Chowk YCM Hospital Road,	
	Midc, Pune-411026,	
	Maharashtra, India	
	08048586519	
5.	Ricon Engineers	Accessories
	10 To 13, Bhagwati Estate,	
	Near Amraiwadi Torrent Power,	
	Behind Uttam Dairy,	
	Rakhial,	
	Ahmedabad - 380023,	

	Gujarat, India	
6.	Future Tech Foods India Private Limited	Vacuum fryer
	No. 11, 202, Phatak Park Apartment,	
	KarveRoad,	
	Next To Tech Mahendra Gate	
	Erandwane, Pune - 411004, Maharashtra,	
	India	
	08048732406	
7.	The Kerala Agro Industries Corporation Ltd	Jack fruit processing
	Agricultural Complex, 1st Floor, Museum	plant
	Road, Near Agricultural Complex, Thrissur-	
	680020, Kerala, India	
	07558880455	
8.	IRS AGRO DIRECT	Chips making
	Shaniwar Peth, Miraj Dist:- Sangli	machine
	Pune 416410	
	Maharashtra, India	



Contact Us

National Institute of Food Technology, Entrepreneurship and Management (NIFTEM) - Thanjavur

(an Institute of National Importance under Ministry of Food Processing Industries, Government of India) Pudukkottai Road, Thanjavur – 613005, Tamil Nadu,India Ph: 04362-228155, Fax:04362-227971 Email: <u>director@iifpt.edu.in</u> Web: https://niftem-t.ac.in/

