PM Formalization of

Micro Food Processing Enterprises (PMFME) Scheme

HANDBOOK

OF

MAHUA

AATMANIRBHAR BHARAT

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CHAPTER 1

1.1 Introduction

Mahua is deciduous tree of dry region and native of India. A multipurpose tree, mostly grown on wastelands in North and Central part of the country where generally tropical and subtropical climates prevail. It grows in Eastern Uttar Pradesh, Chhattisgarh, Maharashtra, Bihar, Jharkhand, Orissa and Andhra Pradesh.
Madhuca latifolia is a medium sized to huge deciduous tree, distributed in Andhra Pradesh, Gujarat, Madhya Pradesh, Orissa, Bihar and Uttar Pradesh. *Madhuca longijolia* is a large evergreen tree found in South India, and in the evergreen forests of the Western Ghats from Konkan Southwards

Mahua is one of the most important trees of Central India. The Mahua trees have large spreading root system, though many of them are superficial. Wood is hard to very hard withlarge sapwood. Hardwood is reddish brown in colour. It is large and deciduous trees with a short Bole and rounded crown. Mahua has a special status among NTFPs as it is linked to thetribal livelihood systems in different ways. Apart from meeting food and other requirements, itis also an important source of seasonal income. Its flowers are used to brew country liquor which is very popular in the tribal areas of the country. The tree has religious and aesthetic value in tribal culture. Mahua flowers and seeds, which have medicinal and nutritional properties, are collected and dried. One single mature tree can provide an income of about Rs.1500 from its flowers and seeds, in addition to various other tangible and intangible benefits. Mahua provides livelihood security to poor households who collect it both for self consumption and for sale the income is used to purchase daily household items. However, in most tribal areas, Mahua gatherers rarely get the true value of produce, which they usually barter for daily grocery items .

Mahua, the Indian Butter Tree (*Madhuca longifolia* (Koenig) J.F. Macribide) is an important tree having vital socioeconomic value and growing throughout the tropical and subtropical region of the Indian subcontinent. It is a deciduous tree that grows widely under dry tropical and subtropical climatic conditions. It is very hardy and thrives well on rocky, gravely, saline and sodic soils, even in pockets of soil between crevices of barren rock .Mahua (*Madhuca indica* J.F. Gmel. syn. *Madhuca latifolia* Macb.) belonging to the family *Sapotaceae.* It is one of those multipurpose forest tree species that provide an answer for the three major Fs *i.e* food, fodder and fuel Fruits are eaten as raw or cooked. The fruit pulp

may be utilized as source of sugar, whereas the dry husk makes a good source of alcoholic fermentation. Seeds are good source of oil (Singh *et al*, 2005). The tree, known under the name of mahua, produces edible flowers and fruits. The leaves of Mahua tree contain saponin, an alkaloid glucoside. Sapogenin and other basic acid have been found in the seeds. Mahua flowers are well known for their high reducing sugar and nutrient content. Flowers of the plant are edible. The corolla commonly called as *mahua* flowers is a rich source of sugar containing appreciable amount of vitamins and minerals .The flowers are also used in preparation of distilled liquor, portable spirits, vinegar and feed for livestock reported that the fresh flowers of Mahua (*B. latifolia* Roxb.), that emit fragrance contain 2 acetyl1pyrroline (2AP), the compound responsible for pleasant aroma in basmati and other scented rice. It was found that 2AP gets synthesized only in fleshy corolla of mature flowers .They are edible and used as a sweetener in preparation of many local dishes like halwa, kheer, puri and burfi .in the mahua production belt of India. However, due to the lack of proper scientific investigation and post harvest processing technologies, they are collected and subjected to open yard sun drying till about 80% moisture is lost, before storage .

1.2 Climate and soil:

Mahua prefers tropical climate. It can withstand drought admirably. This tree does not survive under waterlogged conditions. Since it is a very hardy tree, it can grow even in pockets of soil between crevices of barren rocks. Trees even grow on degraded rocky areas including salt-affected soils. However, for its better growth and productivity, well drained, deep loam soil is ideal.

Cultivation and Collection - This plant can be cultivated or self sown. Flowering of this medium sized tree take place during the season of March to April, in every years.

Botanical Description and Identification Features - A medium sized to large deciduous tree, usually with a short, hole and large rounded crown found throughout the green forest part of India up to an altitude of 1,200 meter and of 12 to 15 meter height, bark thick dark colored cracked, inner bark dark red, milk, trunk short, branches numerous (Behl and Sriwasrawa, 2002) [9]. Leaves are 10-30 centimeter long, are thick and leathery most of leaves pointed at the tip, clustescent glabrred near end of branches, epileptic or elliptic oblong 7.5 to 23 cm into 3.8 to 11.5 cm. coriaceous pubeand when young almost. Flowers are small and fleshy, dull or pale white in color and in define fascicles near end of

branches. Corolla tubular, freshly pale, yellow aromatic and caduceus (Variers and Vaidyarathanam, 1995) [40]. Fruits are 2-6 cm long, fleshy and greenish

1.3 MATURITY HARVESTING AND POST-HARVEST MANAGEMEN-

Fruits are ready for harvest by 3rd week of May to 3rd week of June. Maturity standards in different genotypes of Mahua under different conditions were observed that fruit growth was faster initially and slowed down while reaching towards maturity. Total soluble solids, total and reducing sugars increased as fruits reached towards maturity. Titratable acidity increased during initial period of fruit development, then declined.

1.4 NUTRITIONAL ASPECTS OF MAHUA

	Constituents	Fresh Flowers	Dry Flowers
1	Moisture	73.6-79.82 (%, d.b.)	11.61-19.8 (%, w.b)
2	pH	4.6	…..
3	Ash (%)	1.5	1.4-4.36
4	Total sugars (g/100 g)	47.35-54.06	41.62
5	Total Inverts (%)	54.24	…..
6	Cane sugars (%)	3.43	…..
7	Reducing sugars (g/100 g)	36.3-50.62	28.12
8	Proteins (%)	6.05-6.37	5.62
9	Fats (%)	1.6	0.09-0.06
10	Fibers (%)	10.8	…..
11	Calcium (mg/100 g)	45	0.14-8
12	Phosphorus (mg/100 g)	22	0.14-2
13	Carotene (µg/100 g)	307	…..
14	Vitamin-C (mg/100 g)	40	7

1.5 Uses of Mahua

Used in tribal medicine: In diarrhoea a cup of infusion of bark is taken orally twice a day by the tribals. Besides the stem bark is used in chronic tonsillitis, leprosy and fever . It is commonly used for the treatment of snakebite as antidote for southern part of

Tamilnadu, India . Decoction of stem bark is used to cure skin disease, hydrocoel and skin disease . Powdered bark is employed for the treatment of scabies. *Madhuca longifolia* leaves are expectorant and also used for chronic bronchitis and Cushing's disease . The leaves are applied as a poultice to relieve eczema.

Traditional uses of mahua

- Flower bearing period of mahua is March-April, as it is an annual bearing tree. Flower sheds when it gets mature at dawn. Fresh *mahua* Flowers are sweet in taste and contain different phytochemicals. Traditionally, the fresh flowers are collected and dried under direct sunlight for 2-3 days and stored in gunny bags in normal environment

Use of mahua leaves

- Leaves of Mahua are of very high nutritive value for cattle, goat and sheeps. Trees are lopped for fodder in almost every states, where ever it is grown specially during summer when there is scarcity of fodder. The chemical constituents of Mahua leaves are given in following table

1	Crude protein		9.4-10.02
2.	Digestible crude	protein	0.03
3.	Total digestible	nutrients	37.04
4.	Crude fibre		19.5-0.35
5.	Calcium		1.66
6.	Phosphorus		0.1-0.2

Traditional medicinal uses of *mahua* flowers

medicinal uses	**way of consumption**	**remarks**
Used as tonic	Flower juice	Flower juice having high.
		amount of protein so it
		is used as tonic
Cure skin		Flower juice rubbed on skin
diseases		for oleation to relieve
		from itching

Cure eye		Flower juice is used for
diseases		treatment of eye diseases.
Cure Raktapitta		Flower juice is used to
		arrest bleeding
Cure headache		Flower juice is used
due to "pitta"		as nasal drops
Cure diarrhoea	Flower powder	Flower act as an astringent
and colitis		to cure diarrhoea and colitis
Increases	Raw flowers	Flowers act as a galactogouge
lactation		which can help in augmentation
		of breast milk.
Cure cough	Roasted flowers	……
and bronchitis		
Cure impotency	Flower mixed with milk	……
and general debility		
Cure piles	Flowers fried in ghee	Mahua flower act as a cooling agent

Use of Mahua flower

The flowers of Mahua tree are fermented to produce an alcoholic drink called Mahua, country liquor. Tribals of Bastar in Chattisgarh and Orissa, Santhals of Santhal Paraganas (Jharkhand) and Tribals of North Maharashtra, consider the tree and the Mahua drink as part of their cultural heritage. Tribal people, men and women, consume this drink and is an obligatory item during celebrations and evening activities. The main ingredients used for making Mahua are the Chhowa Gud (Mollasses in granular form) and dried Mahua flowers

Use of fruits

Fruits of mahua are also utilized for human consumption as food. Unripe fruits are used for vegetable preparation in following way: Flesh of mahua fruit covering hard seeds are first peeled off to remove outer thin portion and then

remaining portion are cut into pieces and fried in small amount of mustard oil along with onion and garlic paste Take appropriate amount of mixed spices powder and cook till complete softening of fruit pieces and also to prepare a concentrated curry of mixed spices. In the rural areas of Eastern UP, this vegetable is sometime used as substitute of jack fruit. Fruits contain 55 to 65 percent husk, 10 to 15 percent sugar, 1.8 to 2.4 percent minerals, 51 to 74 mg vitamin C and 586 to 890 IU vitamin A per 100 gram. Because of these above mentioned qualities of fruits these are eaten afresh after ripening in tribal areas and poor of rural areas.

1.6 MAHUA SEED MEAL/CAKE

- After the extraction of oil from oil bearing seeds a major portion of the raw materials is left over as the oilseed cake. Oilseed cakes are good and cheap source of proteins and the market value of the cake is governed by its protein contents and quality of its proteins.
- Mahua seed meal is the product left after extracting oil from Mahua seeds. Seeds yield 30-40 % oil and hence 60-70 of total seed production yields is Mahua seeds meals. Two types of meals are available in the market, Mahua seed meal is used as a detergent and fertilizer. It is also used as manure either alone or in mixture with other cakes and ammonium sulphate.

Value addition of mahua

- Recently Orissa University of Agriculture and Technology, Bhubaneshwar have developed many value-added products from dry *mahua* flowers like candy, cake, RTS, toffee, squash and ladoo.
- Other value-added products like candied flower, glazed flower and *mahua* bar are also developed from dried mahua flowers.

Because of having high amount of fermentable sugars, *mahua* flowers are utilized for making wine by various researchers scientifically using *Saccharomyces cerevisiae*

- Freshly prepared mahua wine has been fortified with traditional Indian herbs (Black pepper, cinnamon, clove, cumin, fenugreek, nutmeg, fennel and Indian cassia) for

development of new value-added product, called *mahua* vermouth

- Dry flowers are also utilized to make fermented products like brandy, acetone, and lactic acid. Beside that all *mahua* flowers can be successfully used as a substrate for surface fermentation using *Aspergillus niger* for production of citric acid .
- The complete detail of the utilization of *mahua* flower recently by various researchers for preparation of value added products is given in table 5 along with them specific remarks

value-added products of mahua flowers

Non-fermented flowers

1 2	Puree & Sauces Juice	Fresh flowers Fresh flower	Fresh flowers are crushed into puree after removal of stamens manually and processed to make puree. Used as a sweetener in bakery
3	Concentrates Mahua Jam	juice Pulp of ripe	and confectionary. Jam is made with addition
4	Jelly	flowers	of citric acid. Combined with guava to
5	Marmalade		reduce astringency of mahua flower. By addition of citrus peels.
7	Glazed flowers		
8	*Mahua* bar		
9	*Mahua* candy		
10	*Mahu*a toffee		
11	*Mahua cake*	Dry flowers	
12	*Mahua squash*		
13	*Mahua ladoo*		
14 15	*Mahua RTS* *Antioxidant rich*	Mahua flower and	RTS blended with ginger extract @ 10 (%) have TSS of 18° Brix and with fennel extract @ 5 (%) have TSS of 14.8° Brix. The blend

			showed TPC of 15.94
	Beverage	Amla juice	(mg GAE/ml) and 91.22 (%) DPPH radical scavenging activity.

Fermented flowers

16	***Mahua* wine**	**Fermentation of flower juice**	**Fermentation at 16° C favours wine quality and increase alcohol content (up to 9.9 %). Sensory evolution reported that addition of yeast during fermentation is acceptable but tannin addition is not required.**

1.7 Heath benefits of Mahua seed

Anti-inflammatory activity: Ramchandra et al. evaluated the ethanol extract and saponin mixture of seeds of *Madhuca longifolia* for anti-inflammatory activity using acute (carrageenan-induced inflammation), sub-acute (formaldehyde-induced inflammation), and chronic (cotton pellet granuloma) models of inflammation in rats. The ethanol extract and saponin mixture at a dose level of 10 and 15 mg/ kg and 1.5 and 3 mg/kg significantly reduced the edema induced by carrageenan in acute model of inflammation, inhibiting both phases of inflammation. Both the extracts had a more effective response than the reference drug diclofenac sodium in the sub-acute inflammation model. Results longifoliated a significant anti-inflammatory activity by *Madhuca longifolia* saponins in cotton pellet granuloma.

Antihyperglycemic activity: The ethanolic extract of seeds of *Madhuca longifolia*was effective in reducing the plasma glucose level in normal albino rats in a dose dependent manner, producing hypoglycemic effect by stimulating the release of insulin from the β-cells and or increasing the uptake of glucose from the plasma

Antibacterial activity: Antibacterial activity of fruits of *Madhuca longifolia* tested against *Bacillus subtilis* and *Klebsiella pneumonia in* ulcer index compared to vehicle, and was near to that of lansoprazole used at a dose level of 40 mg/kg, while crude alkaloid extract exhibited no significant gastroprotective effect

Anticancer activity: Bhaumik et al. studied the *in-vitro* anticancer activity of different extract of fruit seed of *Madhuca longifolia* against human cancer cell line (HeLa) and used MTT assay to analyze the cell growth inhibition. Results of Tables 10-14 showed that the various extracts of fruit-seeds of *Madhuca longifolia* have a very good to moderate anticancer activity

Sugar syrup: There are several reports on preparation of sugar syrup from dry Mahua flowers, as its sweet property isutilized in the fermentation process, The water extract of dried flower is decolorized with differentde colorizing agent like slacked lime and activated charcoal before concentrating it to the desired concentration. Activated charcoal at a concentration of 3.5-5.0 % was found to be the best agent for the preparation of the Mahua sugar syrup The syrup thus obtained from the flower of Mahua is employed in the different purpose, either in the manufacturing of chocolate or as a sweetening agent

Fermented products: Dried mahua flowers are an attractive source of fermented products due to the high sugar content. Prepration of mahua wine from fresh flowers. Various products like alcohol, brandy, acetone, ethanol, lactic acid and other fermented products have been prepared from the dry mahua

Utilization of mahua for processing of different food products Sugar syrup: Sugar syrup from dry mahua flowers, which can be further use as a sweeting agent in different food products with addition of citric acid. The pulp is also converted into marmalade or syrup, which is used as food material. Jelly is also made from the pulp alone or combined with guava to modify the astringent flavor. The pulp is also pickled. Major quantity of flowers is used in the preparation of distilled liquors (Wealth of India, 1962) [3]. Patel, 2008 prepared the mahua jam and jelly by using fresh flowers. The developed products were tested for their colour, flavor, taste, texture and overall acceptability, using hedonic test. According to the findings of hedonic test all the developed Mahua products were found to be highly acceptable.

Nutritional and Medicinal Use: The Mahua tree is having lots of nutritional value in it. It produces fruit which is valued for its seed which yield high quantity of fat commercially known as Mahua butter or mowrah butter, many edible and medicinal applications and it is also used as a biodiesel. Its fat has been used as substitute for cocoa butter and ghee. It is

one of the single largest sources of natural hard fat. The fat which is thus obtained from Mahua fruit oil is used in cooking, frying and manufacturing chocolates. The seed fat has emulsion property so it mostly used as an emulsifying agents in few pharmaceutical industries. It is generally applied as massage oil in many part of the country, as it is very good to moisturize skin. Besides edible and medicinal uses, Mahua has industrial application as it can be utilized in the manufacture of laundry soaps and lubricants. Moreover, the seed cake is reported to have insecticidal and pesticide property and used as organic manure in crops like rice, sugarcane etc. The medicinal properties which are seen in this plant are stimulant, demulcent, emollient, heating. Skin disease, rheumatism, headache, laxative, piles, and sometimes as galactogogue astringent and many more. Review of literature based on chemical composition of mahua flower reveals its high nutritional value. Apart from being a rich sours of sugar and protein, the flowers also contain essential minerals like Ca, p, Fe, and K. Calcium is a major component of the bone and assists in teeth development phosphorus is next in importance to calcium as utilization of Ca is closely related to it. Most of the Calcium in the body is deposited as the calcium Phosphate.

1.8 Nutritional Properties of Mahua flower (Source: Kureel *et al*., 2009)

Constituents	**Flower**
Moisture (%)	19.8
Protein (%)	6.37
Fat (%)	0.50
Total Sugar (%)	54.06
Calcium (%)	8.00
Phosphorus (%) 2.00	2.00
Ash (%)	4.36

Tree-Borne Oilseed Mahua: Seeds of many tree species contain high levels of oil and their use for bioenergy generation has been a topic of interest for long (Raina, 1986). Mahua oil is also edible and is used by tribal communities. All the TBOS are multipurpose in their utility, making them what is desired for agroforestry systems. However, caution is necessary in assessing whether all the uses will be realized at the same

time **Mahua seed oil:** Mahua seeds contain about 40% pale yellow semi-solid fat. The seed oil is commonly known as “Mahua Butter”. The oil content of the seed varied from 33 to 43% weight of the kernel. For the tribals of India, Mahua oil is by far the most important tree seed oils. Fresh Mahua oil from properly stored seeds is yellow in colour with a not unpleasant taste. The oil is used as cooking oil by most of the tribes in Odisha, Chhattisgarh, and Maharashtra etc.

CHAPTER 2
PACKAGING OF MAHUA PRODUCE

2.1 INTRODUCTION

Indian Food Industry is in the thrones of a major revolution, thanks to the economic liberalisation. Demand for fresh produce is increasing in internal market as well as other countries due to globalisation. India is one of the largest producer of horticulture produces both in terms of number of varieties and quantities. Nearly 20-25% of total production is lost every year due to poor handling, storage and transportation methods. The main purpose of packaging is to provide produce with the attributes necessary to survive a number of different hazards which can be expected during storage, transportation and distribution. In recent days, entrepreneurs in India are showing greater interest for the internal marketing as well as export of fresh produce. The trade is attractive but is not an easy enterprise; a high degree of organisation and professionalism is necessary to export fresh produce successfully, especially to the sophisticated markets of Europe. It can make good use of indigenous horticultural skills. The combined requirements of fresh produce and of its transport environment often impose unusually severe conditions on the packaging employed. As a result, higher package quantity is usually needed for fresh fruits and vegetables for manufactured goods of the same weight. For designing of a package for a specific product and particular target market a clear picture of distribution system should be drawn up, as hazards involved in transportation are different for different modes (i.e. packaging requirements for ship transportation are total different than that by air transportation). The models may be used depending upon the characteristics of the produce and the market. Fresh produces are lining tissue, high in 'water content and diverse in terms$_v$of morphology, composition and physiology. So package design should be based on requirement of the product in terms of mechanical fragility, susceptibility to or benefits at high or low relative humidity, limitations or benefits at high or low temperatures and optimum atmospheric composition.

Some of the commodities with high sensitivity to ethylene gas, hence the need to avoid gas build up in transit, which allow for effective external air ventilation (e.g. avocados and package may protect from moisture loss). Certain commodities have special treatments

e.g. sulphur dioxide treatment of grapes. The package assist in protection of commodity against damage, the appropriate design of package and fittings should reduce the chance ofbruising.

2.2 SYSTEMS APPROACH

A systems approach to modern fresh produce processing and distribution organisations includes all the information required for packaging it reproduce, whereby the produce and the package become together the produce sold in the market. This may be grouped into the following :

I. Protection requirement and constraints of the product:

1. Mechanical fragility of the product; ability to sustain prolonged compression shocksand vibration in transit.
2. Susceptibility to or benefits at high or low relative humidity.
3. Tolerance or benefits at high and low temperatures; contaminant hazards.
4. Atmospheric composition conducive to better preserving the quality, or its damagepotential.

II. Marketing requirements of the product:

1. Number of products and number of product (types/grades) in the same container.
2. Weight of the container (gross and net).
3. Means of handling, storage and transportation environment (chain from productionto consumption).
4. Modes and types of wholesale and retail outlets.
5. Modes of quantizing (by weight, by count, by volume, etc.).
6. Modes of coding and labeling (prices, dates, health hazard warnings, utilizationinstructions, etc.).

III. Requirements and constraints of the package:

1. Types of packaging materials, types and construction of containers, standardisation requirements and types of closures. Modes of package manufacturing (in-plant versus contacting suppliers).
2. Modes of empty container storage (in knocked down form?)
3. Feeding containers into the packaging line.

IV. The processing and packaging line in the packaging house:

1. Type and sequence of processing and packaging stages (mechanized, semi-mechanized, manual), number of workers and their skills at each station, etc.
2. Unitizing methods, master containers, bundling, strapping, palletizing, shrink wrapping or stretch wrapping of pallets, airline or maritime containerization, etc.

V. Quality criteria of alternative packaging systems available:

1. Total packaging cost per unit product.
2. Containment and protective qualities, marketability and salability.
3. Disposal or recycling possibilities of the package.

2.3 PACKAGING HOUSE OPERATION:

The packaging line begins with unloading harvested produce. Bulk bins of 200-500 kg capacity are used for big packaging houses but in India reusable plastic crates are used. Freshly harvested produce stacked up for interim storage. Interim storage may serve several purposes, depending on the type of produce. Latest damage, sustained during harvesting, will appear as visual defects several hours later and can be detected. Storing field-warm produce for few hours in a cool place, such as cold storage corridors, whereby produce temperature is reduced by several degrees before processing will help reducing subsequent spoilage and damage in the packaging line.

The most important process in fresh produce is respiration, a biochemical oxidation of all living cells. Respiration rate is proportional to temperature, approximately doubling for every 10°C. Due to high respiration, heat build up will be more, which in turn increases the temperature and respiration of produce. This reduces shelf-life of the produce. The heat produced may be calculated by

1 mg CC>2/kg hr. = 61.2 k.cal/metric ton. day = 220 BTU/ton.day.

The term precooling refers to several practices whereby the temperature of the freshly harvested produce is quickly lowered to shorten the period of initial high respiration rates as well as to reduce the loads on the long-term cold storage facilities. Success of efficient precooling depends upon fast removal of field heat from all fruits, preferably within 2 to 3 hours. Regular cold storage room with about 150 air changes per hour gives best result, but with danger of excess moisture loss.

Hydrocooling consist of drenching field-warm produce with stream of cold water taking care of chilling injury suitable for leafy vegetables. There are three types of hydrocoolers. Immersion, flooding and spraying. Another precooling method suitable for lettuce is vacuum cooling. This system uses hermetically sealed vacuum chambers whereby the pressure is reduced until the vaporising temperature of water is near O°C (4.6 mm Hg), removes moisture uniformly from all tissues, not just from the surfaces. The produce are subjected to a cleaning process, which begin with soaking tank, where dirt clods and pesticide residues are softened and diluted by warm or cold solution of water detergents and disinfectants. The fruit is thoroughly washed by piece of cloth or soft brushes with water spray. The produce is then treated with fungicide treatment if any. Before processing further, produce is dried by air steams from overhead fans. In the next stage the undersized produce called as culls, is eliminated can be sent for converting, called as presizer stage.

The grading process next follows to segregate the produce into quality groups, such as

ripe fruits which must be marketed immediately, grade A,B,C, export grade or culls. Before or after grading, high quality fresh produce processing may be included a waxing, operation, especially when long shelf-life is desired. Most produce has a natural wax layer on its rind or skin which protects it from excessive moisture loss while allowing free metabolic gas exchange. This wax is largely removed by the cleaning operation. By applying an artificial wax, the keeping quality of produce is reinstalled or even bettered, which includes chemical additives to inhibit spoilage or to add gloss to colour for sales appeal. Sizing is an additional sorting operation whereby sorting attribute is size. Now uniformly sized and graded produce is ready to be packaged. Depending upon produce type and grade, distance to markets, cost and availability of packaging materials, the produce may be packed in a large variety of shipping containers.

The packaging operation usually includes set up of container, before quantitizing of produce, filling and container closure. Quantitizing may be by count or by weight or a combination of the two. Accurate sizing provides proportional link between count and weight whereby only 'check-weighing' is required after filling by count. Container fill may be random or pattern packed. Pattern packed increases protection of produce, by minimising contact pressure by increasing number of contact points until its maximum of 12, is emphasized and maximising volume utilisation. Sometimes the produce is pre-packed in packaging house in consumers pack, mostly different types of plastic bags or overwrapped trays. The final packaging operation is container closures which may be performed by gluing, stapling, strapping. Unitization and palletization may be done according to the container requirement and market need.

2.4 Types of packaging: Packaging can be classified in number of ways; the most importantone is by stages of distribution system for which it is primarily intended.

- Consumer or unit packaging,
- Transport packaging;
- Unit load packaging.

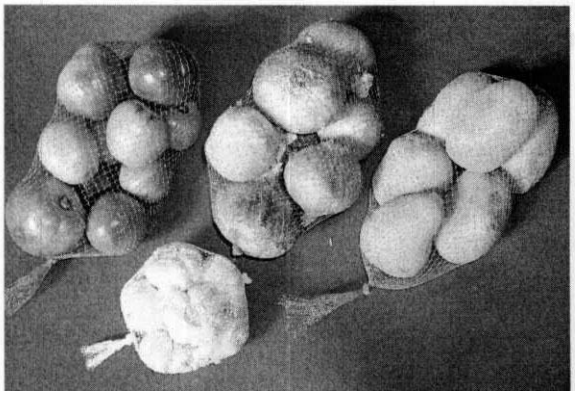
Consumer packaging

The package in which consumer receives the produce is called consumer packaging. The term prepackaging of produce in consumer units prior to its presentation to the final consumer. Prepackaging may be undertaken at any stage throughout the distribution chain from the field to the retailers premises, depending upon, need of produce for protection, expected transport and storage time, required shelf-life, packaging material costs and costs of packaging and sorting at different points, transport and storage cost

and latest knowledge of the market requirements.Types of consumer package:

Bags :

Bags are ...erial and packaging ...ethylene or 12.5 m... used to provide c... as citrus fruits, onions potatoes etc. The bags can be made of paper, perforated polyethylene or polypropylene film, plasticor cotton nets.



Net bags

Perforated bags

Tray:

Tray packs made of foamed polystyrene or PVC or PP are overwapped with heat shrinkable or stretch films. A tight wrap immobilizes the fruits and keep them apart. Trays of moulded pulp, card board, thermoformed plastic or expanded polystyrene are used.

Sleeve packs:

Combine the low cost of bags and protective qualities and sales appeal of tray packs. Wraps of plastic film such as polyethylene or PVC, in the form of shrink-wrap, stretch film or cling film. Regular net stocking or expanded plastic netting can also be used. The traditional fruits and vegetable retail trade packs the produce in the presence of consumers and in the qualities and quantities required by them. The package normally used is a simple wrap of paper or a paper or polyethylene bag. Sleeve packs can be fabricated to contain from one to as many as ten fruits. The main advantage in sleeve packs is that they immobilize the produce at a fraction of cost of tray packs and produce can be observed from all sides without damage to the fruit.

Transport packaging:

The transport packaging for fresh produce may be divided into two size groups:

i) The predominant size group, suitable for carrying by man, is in the range of 15 to 25 kg.

ii) The other group, recently becoming increasingly popular is in 200-500 kg range suitablefor fork lift handling refers to as pallet container.

Wooden boxes:

Includes natural wood and industrially manufactured wood-based sheet materials. Timber used must be inexpensive and easily worked. All wood that is used for the production of the packaging should be well dried in order to prevent cracks and mould growth later. Manufactured wood based sheet materials include ply wood, hard board and particle board. Plywood is usually made from birch. It is rigid and strong, though perhaps somewhat less resistant to splintering than poplar, but is smoother and flatten so suitable for direct printing. Hard board is dark in colour but its appearance can be improved with decorative printing, but deforms after long storage in high relative humidity. Particle board is thicker and rigid but relatively brittle.

Corrugated fibreboard boxes:

Corrugated fibreboard boxes are the most commonly used shipping containers where cartons, glass, cans and pouches are the unit containers. The popularity of CFB as a container in food industry as well as in other industrial packaging is for the followingreasons:

1. Low cost to strength and weight ratio.
2. Smooth, no abrasive surface.
3. Good cushioning characteristics.
4. Excellent printability.
5. Easy to set up and collapsible for storage, and

6. Reusable and recyclable market.

Corrugated fibreboard boxes

The most commonly used material for plastic corrugated box is polypropylene and HOPE. Its advantage over CFB is low weight to strength ratio and its reusability. The printability is also excellent when compared to CFB boxes. But CFB has edge over plastic fibreboard boxes when cushioning properties are taken into consideration. The disadvantages are ultraviolet degradation and temperature resistant.

Plastic crates

Plastic crates are usually made up of HOPE or Polypropylene by injection moulding has been replacing wooden and wire crates. These crates must have good resistant properties to ultraviolet degradation and shock damages.

Sacks:

These are flexible shipping containers which are generally used in food industries to bring to raw materials viz. fruits and vegetables from the field. If the weight of content is more than 10 kg then it is called sack otherwise bags. The commonly used materials for sacks are cotton, jute, flan, plastics (HOPE, Polypropylene). These sacks are advantageous to use as it cost less, high strength, reusability and requires small space for the empties. Disadvantage of plastic woven sack is poor stackability due to low coefficient of friction.

Palletization:

Pallets have been standardised keeping in view of the standard package sizes and sea containers. The size of the pallet take on a strategic importance since they correspond directly to the sizes of the various types of containers, ship cargo compartments, trucks, fork trucks, etc. Most commonly used pallet sizes are 120x80 cm (Euro pallet) and 120x100 cm (Sea pallet). Sea pallets are most commonly used outside the Europe.

Palletized loads are used in order to reduce handling costs by allowing the substitution of mechanical handling for manual methods.

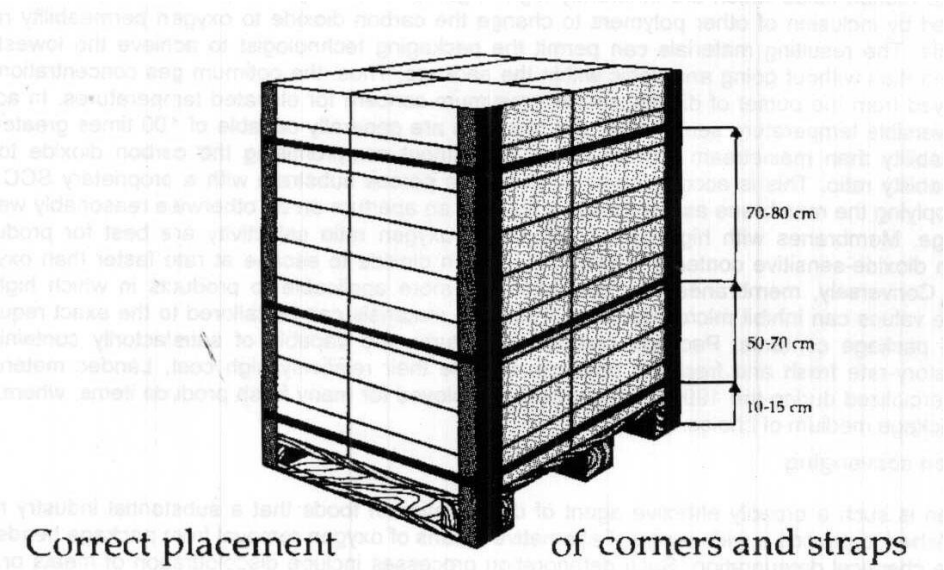
- A decrease in sorting.
- Redraw labelling requirement.
- Better utilization of storage space.
- A reduction in mechanical strains and damages.
- A reduction of the total distribution time.
- A better maintenance of product quality.

Two principles are used in the assembly of pallet loads.

1. The modular principle, in which all package are oriented in the same direction.
2. The two-way principle, in which the packages in each tier form a pattern such that some packages are oriented lengthwise and other cross wise on the pallet.

Unitization :

Corner posts made with plastic or wood or Moulded paper boards is generally used as columns for unitization. The boxes are held together by means of strapping around the boxes as shown in below.



Correct placement of corners and straps

Modified Atmosphere Packaging (MAP)

A modified atmosphere is the initial alteration of the gaseous environment in the immediate vicinity of the product, permitting the packaged product interactions to naturally vary their immediate gaseous environment.

A controlled atmosphere is a process by which the gaseous environment is modified to a desired level and controlled at this level, with strict limits, throughout storage and is usually applied to bulk storage.Normal composition of air 20% O2, 79% N2, 0.03% CO2.

Smart packaging

To be able to control the package structure to deliver controlled atmosphere within packages is a major accomplishment that truly deserves the name "smart packaging." The term "smart" packaging was coined about fifteen years ago to describe package structures that allegedly sensed changes in the internal or surrounding environment and altered some of their relevant properties in response. Simultaneously, academics and true researchers, concerned that the term was too juvenile, invented the term "interactive" packaging to describe the same entities and later shortened it to "active" packaging, the nomenclature employed today. The problem with too much active packaging today is that it is not very intelligent, i.e., it does not really change with environment but rather functions in a less passive fashion than "ordinary" "barrier" packaging.

Intellipac™ polymeric package materials, manufactured by Landec Corp., Menlo Park, Calif., are side-chain-crystallizable (SCC) polymers with the ability to effectively and reversibly melt as the temperature increases and thus foster increased gas transmission through them. SCC polymers are acrylics with side-chains independently of the main chain. By varying the side- chain length, the melting point can be altered. By making the appropriate copolymers, it is possible to produce any melting point from 0 to 68 0 C., well within the extreme distribution temperature range of minimally processed foods. SCC polymers are unique because of their sharp melting transition and the ease with which it is possible to produce melting points in a specific temperature range. When elevated to the switch temperature, SCC polymers become molten fluids which are inherently high in gas permeability. The permeation properties may be modified by inclusion of other polymers to change the carbon dioxide to oxygen permeability ratios, for example. The resulting materials can permit the packaging technologist to achieve the lowest oxygen concentration

without going anaerobic within the

package. Thus, the optimum gas concentration may be employed from the outset of distribution with minimum concern for elevated temperatures. In addition to the reversible temperature sensitivities, the materials are generally capable of 100 times greater oxygen permeability than mainstream polyethylene films without compromising the carbon dioxide to oxygen permeability ratio. This is accomplished by coating a porous substrate with a proprietary SCC polymer and applying the membrane as a package label over an aperture on an otherwise reasonably well sealed package. Membranes with high carbon dioxide to oxygen ratio selectivity are best for products with carbon dioxide-sensitive contents to allow the carbon dioxide to escape at rate faster than oxygen can enter. Conversely, membranes with low ratios are more applicable to products in which high carbon dioxide values can inhibit microorganisms. Thus, the materials can be tailored to the exact requirements of the package contents. Package materials structures are capable of satisfactorily containing high- respiratory-rate fresh and fresh-cut produce. Despite their relatively high cost, Landec materials were commercialized during the 1990s and are being employed for many fresh produce items, where they are the package medium of choice.

Oxygen scavenging

Oxygen is such a broadly effective agent of deterioration in foods that a substantial industry has been established to provide a wide range of alternative means of oxygen removal from package headspaces to reduce chemical deterioration. Such deterioration processes include discolouration of meats or rancidity development due to lipid oxidation.

The choice of method of oxygen removal depends upon both economic factors and upon the properties of the particular food. In practice the application of a short inert-gas flush coupled with use of a scavenger is likely to be an attractive combination.

The performance of oxygen scavenging sachets depends strongly on the equilibrium relative humidity of the food and the range of sachets available. The inclusion of iron-based scavenging compositions in sachets has been improved by development of adhesive scavenging labels for the inner wall of packages.

Technologies for thin films typically used in MAP systems need an additional feature to prevent premature reaction if they are to provide maximum scavenging capacity. The transition-metal-catalyzed (optionally light-activated) process patented by W.R. Grace, Inc.

approaches this by pre-planned activation involving generation of full capacity by consumption of antioxidants. Amoco Chemicals have reported some performance data for their Amosorb®, water-activated, masterbatch for blending into a variety of plastics. No compositional detail is yet provided but the masterbatch and plastics incorporating it are stable at relative humidities below 40%.

Co2-scavengers and emitters

Co2 is formed in some foods due to deterioration and respiration reactions. The produced Co2 has to be removed from the package to avoid food deterioration and/or package destruction. Co2-absorbers might therefore be useful. The 02 -and Co2 -scavenging sachet FreshLock® or Ageless® E is used in coffee to delay oxidative favour changes and absorb the occluded 602 which if not removed would cause the package to burst . The active compound Ca(OH)2 of FreshLock® reacts at suffciently high humidity with the Co2 to produce CaCoa. Multiform Desiccants patented a Co2 -absorbent sachet including a porous envelope containing CaO and a hydrating agent such as silica gel on which water is adsorbed.

In some cases, however, high 602 -levels (10-80%) are desirable for foods such as meat and poultry because these high levels inhibit surface microbial growth and thereby extend shelf-life . Fresh meat, poultry, fish and cheese can benefit from packaging in a high Co2 -atmosphere. Removal of 02 from a package by use of 02 -absorbers creates a partial vacuum which may result in a collapse of flexible packagings. Also, when a package is flushed with a mixture of gases including €02, the Co2 dissolves partly in the product and creates a partial vacuum. In such cases, the simultaneous release of Co2from inserted sachets which consume 02 is desirable. Such systems are based on either ferrous carbonate or a mixture of ascorbic acid and sodium bicarbonate. The 02 -absorbers/Co2 -generators are mainly used in products where package volume and package appearance are critical.

Antimicrobial packaging

Substantial recent research has been directed at determining how the surfaces of plastics can be made not only sterile but also capable of having an antimicrobial effect on the packaged food or beverage. This type of effect has already been achieved in outer layers of laminates by use of modified printing presses.

Horseradish extract on a cyclodextrin carrier has been used in a drip sheet for fish or in a film wrap for lunches in Japan.

Approaches to antimicrobial packaging can be classified as either of two types. The first consists of binding an agent to the surface of packages and this would require a molecular structure large enough to retain activity on the microbial cell wall even though bound to the plastic. Such agents are likely to be limited to enzymes or other antimicrobial proteins. The second approach involves the release of agents into the food or beverage or localized removal of a food ingredient essential for microbial growth.

prepackaging

The package in which consumer receives the produce is called consumer packaging. The term prepackaging of produce in consumer units prior to its presentation to the final consumer. Prepackaging may be undertaken at any stage throughout the distribution chain from the field to the retailers premises, depending upon, need of produce for protection, expected transport and storage time, required shelf-life, packaging material costs and costs of packaging and sorting at different points, transport and storage cost and latest knowledge of the market requirements. The experiments carried out at CFTRI showed the extended shelf-life of different fruits, vegetables and cut flowers are shown in table:

Labelling:

Handling information.

This side up-symbol.

Fragile-symbol.

Temperature symbol min. 12°C., max. 14°C.

Produce information on **"produce short side".**

Origin : Country

Optional : District or regional or local place name

Produce : Mangoes

Variety : Name of variety.

Net weight : **in** kg.

Count : Number of fruits in the package.

Size : Optional

Packed : Date of packaging.Produce information **"other short side"**

Tare : Tare weight in kg. (Max. + deviation in %)

Packer or dispatcher : Name and address

Grower : Name and address

2.5 MARKETING

- Mahua being essentially a forest crop, there is lack of organized marketing process. In forest areas the proportion of flowers and seed collection is much less than the areas around . villages. However local middlemen purchase the dehulled kernels of mahua from villagers and supply it to wholesale markets. It ultimately reached to expellers from wholesale market.
- About 75 % of farmers sell their produce at farm level to the village merchants, retailers, big producers or to pre harvest contractors. They cannot afford to transport their produce to distant markets on account of non availability of transport facilities, expensive transport, and malpractices in market. Information regarding demand, supply, price, market outlook, knowledge of consumer's preference, marketing channels are important for marketing of produce.

2.6 Conclusion

- The research workers have to come along with the people of tribal community, so they may have more and valuable knowledge. In coming next generation the importance of plant and mahua tree is going to be increase because of their effectiveness, easy availability, low cost and comparatively being devoid of toxic.
- Plants are the important economical source of a number of well established drugs looking upon wide prospects and potential of *Madhuca Indica* for various purposes; it is

worthwhile to cultivate this plant on large scale especially on unproductive and wasteland. This will help in financial full support of poor and landless families. Generally this plant *Madhuca Indica* is known only for its liquor making purpose, but one have to come forward to change the thinking of unaware people

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CHAPTER 3

3.1 Food Safety and Regulatory Requirements for Mahua Processing

- Any food business operation to function in India should adhere to certain product specific standards, safety and hygienic parameters.
- The food safety regulations are laid down by Food Safety & Standards Authority of India, **came into existence in 2006**.
- Other agencies involved in standardization and quality certification are Bureau of Indian Standards (**BIS**), **AGMARK, Codex**.
- FSSAI replaces the then existed laws like Prevention of Food Adulteration Act (1954), Fruit Products Order, Milk & Milk Products Order, Export (Quality Control & Inspection) Act, Meat Products order, Agricultural Produce (Grading & Marketing) Act
- Every food business operator involved in the manufacture, processing, storage and distribution and sale of food products must compulsorily obtain FSSAI Registration or License.
- It is a 14-digit registration of a license number which is printed on all the food packages. The 14-digit registration number gives details about the assembling state, producer's permit.

FOOD SAFETY AND STANDARDS AUTHORITY OF INDIA (FSSAI)

- **The Food Safety & Standards Authority of India** is the **principal Government Authority** responsible for preparing specific regulations under the Act. **FSSAI** is an autonomous body established **under the Ministry of Health & Family Welfare, Government of India**
- **FSSAI** has been established under the **Food Safety and Standards Act, 2006**
- **Came in to action- August 2011**

- **FSSAI is responsible for protecting and promoting public health through the regulation and supervision of food safe.**
- Businesses having annual turnover above 20 crore can apply for FSSAI central license.
- 1. Rental Agreement of Business Premises.
- 2. ID Proof of the Concerned Person (Aadhaar Card / Driving License / Passport / Voter ID)
- 3. If any Government Registration Certificates (Company Incorporation Certificate / Firm Registration / Partnership Deed / Pan card / GST / Shop & Establishment / Trade License)
- 4. If the applicant is private limited company or partnership firm then they should provide MOA & AOA or Partnership deed copy.
- 5. IE Code (Import Export Code) Certificate (for the category of export and import IE code is compulsory)
- 6. Authority letter from the company letterhead to the concerned person stating that he is authorized to file FSSAI application.
- 7. List of food category desired to be manufactured (In case of manufacturers).

3.2 HACCP PROCEDUER

Appropriate to the nature and size of the operation and sufficient to assist the business to verify that the HACCP controls are in place and being maintained.

Documentation shall include (as a minimum) the following:

- HACCP team composition;
- Product description;
- Intended use;

- Flow chart;
- Hazard analysis;
- CCP determination;
- Critical limit determination;
- Validation process; and
- HACCP plan

The HACCP plan shall include the following information for each identified CCP:

- Food safety hazard(s) to be controlled at the CCP;
- Control measure(s);
- Critical limit(s);
- Monitoring procedure(s);
- Corrections and corrective action(s) to be taken if critical limits are exceeded;
- Responsibilities and authorities for monitoring, corrective action and verification;

  Record(s) of monitoring