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SAMETI, Kudumiyanmalai.

GOVERNMENT OF TAMILNADU

DEPARTMENT OF AGRICULTURE

UNDER SSEPERS – ATMA -2021-2022

VALUE ADDITION OF HORTICULTURAL CROPS

TECHNICAL MANUAL

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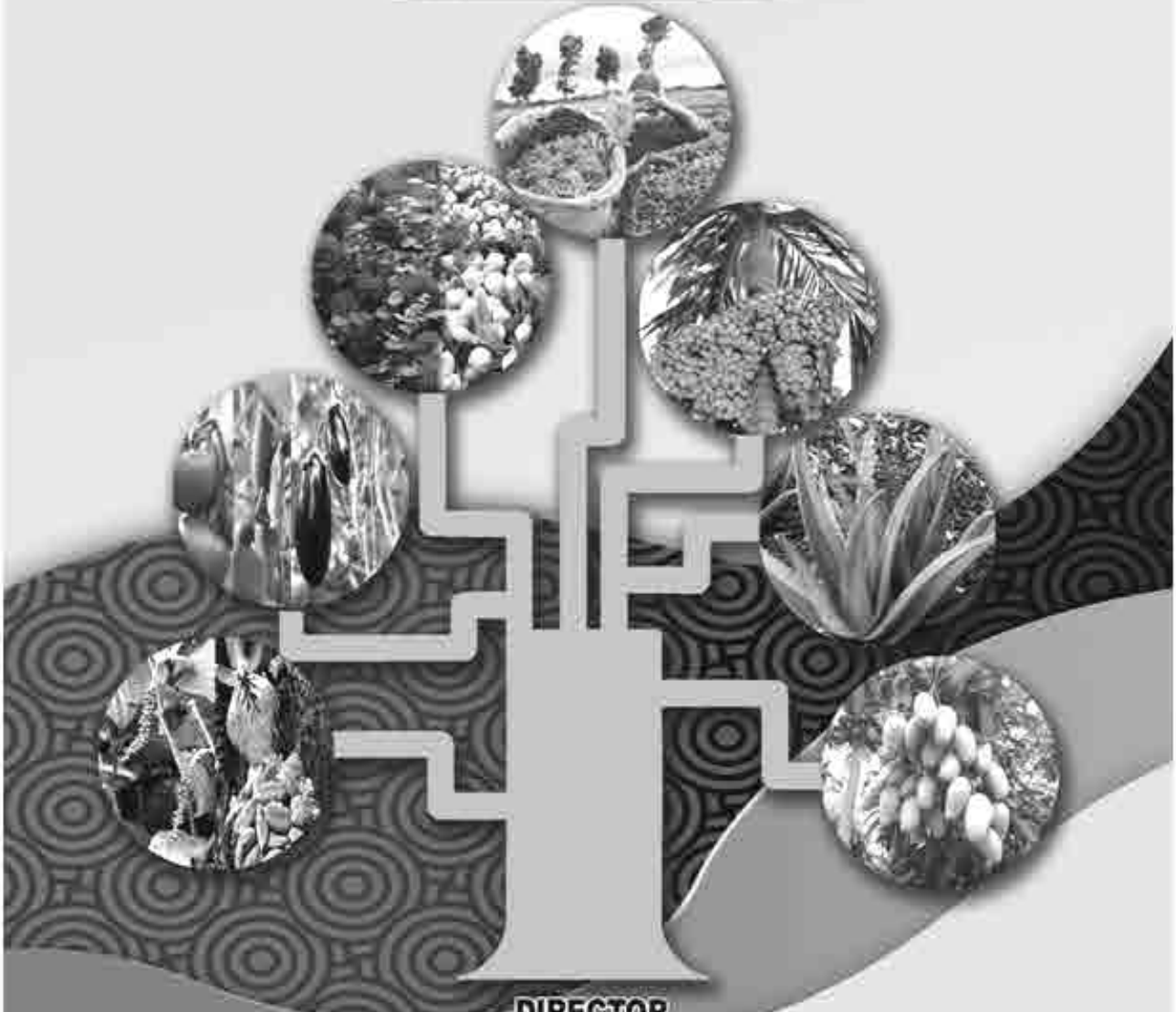

DIRECTOR

STATE AGRICULTURAL MANAGEMENT AND EXTENSION TRAINING INSTITUTE (SAMETI)

KUDUMIYANMALAI.

DEPARTMENT OF AGRICULTURE

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Foreword

Tamil Nadu is one among the leading Horticulture States contributing 5.5% towards Production of Fruits and 4.9% towards production of Vegetables at National level. Tamil Nadu accounts for nearly 4.4% of the area under fruits and 2.3% of area under vegetables in the Country. The area coverage of fruits and vegetable crops in Tamil Nadu is 7 Lakh Ha, fulfilling the growing nutritional demand of the increasing population.Tamil Nadu is the leading producer of Loose Flowers contributing 24.5% to Nation's production.

To minimize the post-harvest losses and to utilize the produce effectively, fruits and vegetables may be processed and converted into food products like jam, jelly, squash, crush, pickle, dry fruits, etc. These food products can be stored and used for longer time than the fresh produce.

The Horticultural sector encompasses a wide range of crops. The horticulture crops include fruits, vegetables, spices, plantation crops, medicinal crops and flowers. The percentage share of horticultural crops in value of total agriculture output is around thirty percent. It is a matter of pride that India is the second largest producer of vegetables and fruits in the World. The country takes at first position in the production of Banana, Mango, Lime and Lemon, Papaya and Okra.

Horticultural sector has become one the major driven of growth in the agricultural sector. Horticultural sector provides employment opportunities across primary, secondary and territory sectors. Horticultural crops, particularly fruit crops are negatively resilient to changes in weather conditions. Vegetables are mostly grown by small & marginal farmers and augment the income of farmers. This sector also enables the population at large to enjoy a diverse and balanced diet for health living the sector has gained prominence over the last few years contributing a growing share in Gross Value Added of the agri & allied sectors.

In this connection SAMETI has planned to conduct within the state training programme on **"Value Addition of Horticultural Crops"** to Extension officials of Department of Horticulture and Plantation Crops to disseminate the technologies among farming groups also increase the income of farmers through value addition.

I am pleased to place record to all the contributors of technical material for the preparation of Manual. As well, I appreciate the technical staff of SAMETI for coordinating to bring the training manual as an informative record.

Best wishes

Date:- 01.10.2021

Director,

Place:- Kudumiyanmalai

SAMETI, Kudumiyanmalai

INDEX

SCOPE AND IMPORTANCE OF VALUE ADDITION OF HORTICULTURAL CROPS

Introduction

Fruits and vegetables are an important supplement to the human diet as they provide the essential minerals, vitamins and fibre required for maintaining health. In India, the total fruits and vegetable production is about 137 million tonnes per year i.e. 46 Million Tonnes fruits and 92 Million Tonnes vegetables. The varied agro climatic conditions available in our country make it possible for us to produce several types of tropical, subtropical and temperate fruits and vegetables. It has been variously estimated that 20 to 30% of the horticultural produce is lost before consumption which accounts for Rs. 5000 crores because of poor harvesting, handling, storage, transportation and marketing practices. The fruits and vegetables are highly perishable commodities and the ambient high temperature obtained in the tropical country like ours makes them more susceptible for rapid development of senescence, decay and rotting. Both respiratory and transpiratory rates are proportional to temperature, increases and so that the produce quickly dries, wilts and spoils unless properly preserved.

Two approaches are possible for solving this problem. One is the creation / expansion of cold storage facilities in the fruit and vegetable producing regions themselves, as also in the major urban consumption centres, to ensure supply of fresh fruits and vegetables throughout the year. Another approach is to process the fruits and vegetables into various products which could be preserved for a long time and add to the value of the product. With increasing urbanization rise in middle class purchasing power, change in food habits and the dying out of the practice of making preserves in individual homes, there is increasing demands for factory made jams, jellies, fruit beverages, dehydrated foods, pickles etc. in the domestic market. Moreover, there is considerable demand for some of these products in foreign markets e.g. mangoes both fresh and canned, fruit juices, salted cashew are good foreign exchange earners.

The production of fruit and vegetable products in India are canned, bottled fruits and vegetables, jams, jellies, marmalades, fruit juices, fruit pulps, squashes, crashes, cordials, fruit syrups, fruit nectars, Ready to Serve fruit beverages, fruit juice concentrates, chutneys, pickles, mango slices in brine preserves, candied and crystallized fruits and peels, dehydrated fruits and vegetables, frozen fruits and vegetables, tomato products, sauces, soups etc.

In India there are 4000 processing industries are functioning. But a marginal quantity of 1.0 to 2.0 % of the produce is processed and packaged in contrast with developed and developing countries i.e., 70 to 80%. The total annual consumption of processed fruits and vegetable products in the country is rockened at only 50,000 tonnes of which defence and star hotels account for 15,000 tonnes and the remaining 35,000 tonnes to the public, i.e. a per capita consumption of 40 gms / year. Thus we can see on enormous scope and potential for the expansion of fruits and vegetable industries in India in the future.

Export of fruits and vegetables from India

In terms of global trade, India's share in agricultural export is insignificant. While India contributes 8.56% and 13.5% respectively to world's fruits and vegetables production, its share in global exports of these products is less than 1.0%. Delhi, Bombay and Trivandrum are the three main parts for air freighting of fruits and vegetables. These are mainly exported to Kuwait, Dubai and Saudi Arbia. Grapes are exported in large quantities from Bombay during January to March, while mango is exported during April to June. West Asia, the Far East and West Europe are the main export markets for Indian fruits and vegetables. Fruits juices, fruit pulp and pickles are mainly imported by the USSR, Yemen, Arab Republic. The other markets for processed fruits are UK, UAE, Saudi Arabia, Kuwait, Germany, USA, Holland and Switzerland. Nearly half of India's processed fruit exports are mango based fruit juice, canned and bottled fruits.

Fresh onions and mangoes are the main commodities entering in export trade. The other important fruits exported are melon, sweet melon, grapes, pomegranate, sapota, custard apple, orange, papaya, pineapple. Among vegetables the principal items are tomato, ladies finger, bitter gourd, chillies, fresh beans, cabbage, brinjal etc.

Objectives of fruit and vegetable processing

1. To reduce wastage and losses: Fruit and vegetable industry is the backbone of horticulture industry as it takes care of all possible waste that occurs in spite of improvement in the distribution and marketing of fresh produce.
2. To handle glut: Produce during glut season utilized for making different processed products, thus fruit processing helps in reducing wastage and handling excess produce during glut season.
3. To stabilize farm prices and income: It stabilizes farm price by utilizing the excess produce in valueaddition to provide additional income to the farmers.
4. To utilize marketable surplus: Processing utilizes marketable surplus as well as cull and deformed produceto ensure remunerative returns to the growers.
5. To generate employment: Processing of fruits and vegetables being a labour intensive helps to generate both direct and indirect employment for the masses.
6. To add variety to the diet: Value addition/processing make the food more attractive and palatable.
7. To ensure nutritional security.
8. To earn foreign exchange through export of processed fruit and vegetable products.

Major constraints in expansion of food industry

1. Variation in fresh produce quality involving frequent changes in production schedules.
2. Low productivity and high cost of raw material: Low production percent area in our country in comparison to horticulturally advanced countries is one of the major factors leading to high cost of raw material.
3. Lower quality of raw material (low in soluble solids) in our country leads to requirement of comparatively more raw material for production of equivalent quantity of finished products, thus resulting in higher cost of production .
4. Non availability of cost effective technologies for processing and packaging of fresh and processed products.
5. Lack of infrastructure for post harvest management, cool chain and cold storages.

6. Non-availability of trained man-power.
7. Low domestic demand of processed fruit and vegetable products due to high cost.
8. Irregular in supply and non-uniform quality of processed products due to variation in raw material quality and use of batch processes.
9. High cost of packaging material, higher taxes and excise duties.
10. Low capacity utilization in food industries.
11. Financial and fiscal constraints.
12. Infra-structural constraints in processing.
13. Inadequate farmer-processor linkage; leading to dependence on intermediaries.
14. Lack of strategies for market promotion.
15. Lack of strategies for utilization of processing industries waste (pomace, peel, core, stones/seed) for valueaddition.
16. Lack of R&D in food processing sector and its linkage with the food industry.

Prospects for growth of processing industry

In spite of large number of constraints, the prospects for growth of processing industry are very high due to following factors:

1. Increased urbanization.
2. Changing life style and food habits.
3. Increase in purchasing power of the population.
4. Change in consumption pattern.
5. Increased awareness of population about health promoting foods.
6. Increased demand for functional foods, organic foods, convenience foods and diet foods.
7. Expansion of organized food retail.
8. Increase in population of working women having less time for spending in the kitchen. Thus need for processed convenience foods.

The stage of crop production immediately following **harvest**, including cooling, cleaning, sorting and packing may be termed as Post Harvest Handling.

Fresh Fruits and Vegetables including root crops are mostly perishable in nature. They begin to deteriorate immediately after its separation from the parent plant and suffer considerable losses during the process of Marketing. These losses may be of following nature:-

1. Quality downgrading due to handling
2. Physiological spoilage (rooting & sprouting)
3. Pathological Spoilage from pest and diseases
4. Over supply to markets

Main Reason of Post Harvest Losses:-

1. Inadequate or Inappropriate application of proper Post Harvest Practices.
2. Improper production planning.

On the Other hand, Value Addition in Horticulture is the process in which a high price is realized for the same volume of a primary product, by means of processing, packing, upgrading the quality or other such methods. For example: Making Jam of Pomegranate and Strawberry.

Need for value addition in Horticulture:-

- To improve the profitability of farmers.
- To empower the farmers and other weaker sections of society especially women through gainful employment opportunities and revitalize rural communities.
- To provide better quality, safe and branded foods to the consumers.
- To emphasize primary and secondary processing.
- To reduce post harvest losses.
- Reduction of import and meeting export demands.
- Way of increased foreign exchange.
- Encourage growth of subsidiary industries.
- Reduce the economic risk of marketing.
- Increase opportunities for smaller farms and companies through the development of markets.
- Diversify the economic base of rural communities.
- Overall, increase farmers' financial stability.

Importance of Value Addition in Horticulture:-

- Horticulture deals a large group of crops having great medicinal, nutritional, health promoting values.
- India as second largest producer of fruits and vegetables, only below 10 per cent of that horticultural produce is processed, but other developed and developing countries where 40-80 per cent produce is value added.
- Horticultural crops provide varied type of components, which can be effectively and gainfully utilized for value addition like pigment, amino acids, oleoresins, antioxidants, flavors, aroma etc.
- Post harvest losses in horticultural produce are 20 to 30 per cent which amounts to more than 5000 crore rupees per annum. If we subject our produce to value addition the losses can be checked.
- Horticultural crops are right material for value addition because they are more profitable, has high degree of processing ability and richness in health promoting compounds and higher potential for export.

POST HARVEST EQUIPMENTS/ STRUCTURES FOR FRUITS AND VEGETABLES

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Grading Technologies

1. Colour sorter

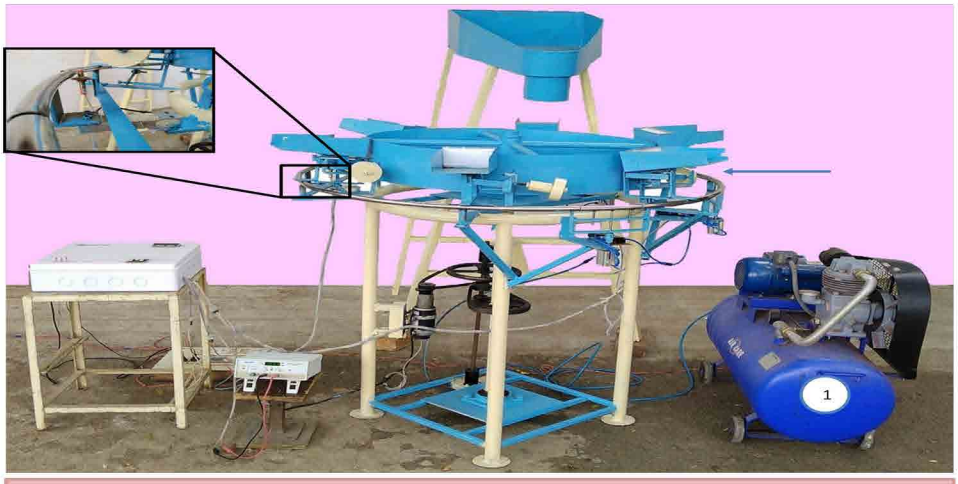
The color sorter cum size grader works on the principle of energetic reflection based on measuring the intensity of light and it comprises of feed hopper, chain conveyor, belt conveyor, TCS3200 sensor, collecting ducts, inlet hopper, grader, outlet section and collecting trays. Developed machine was operated by a single phase 2 hp motor. Based on the performance evaluation the maximum grading efficiency obtained was 94.5%. The sensor senses 1800 fruits/h (i.e. one fruit per 2 seconds).

2. Size Based Grader for Spherical Fruits

A size based grader is developed for spherical fruits and vegetables. Totally five collecting trays were fixed with 350 mm length converging to 200 mm and 100 mm width. The inclination of collecting trays can also be adjusted so that we can use for all types of spherical fruits and vegetables with no damage. The length of the feeding section was 150 mm to ensure that each fruit comes in contact with the metering aperture. In the grading section 5 number of outlets were give in order to separate the fruits and vegetables into 5 different grades.

3. Weight based grader for fruits

A sensor based weight grader was designed and developed to grade pomegranate based on weight with a singulating feed conveying mechanism. It consists of a compressor, DC motor, electronic circuits, load cells, sensor, feed hopper, carrier cap mechanism with RPS unit. The capacity of the machine is 100 kg/h.



1. Compressor 2. DC Motor 3. Electronic circuits & Hardware 4. Load cell and Sensor assembly 5. Feed hopper 6. Carrier cup mechanism 7. RPS unit

Vegetable washer

The vegetables are fed into the rotating drum is made of stainless sheet punched with rectangular holes to spray the water. The rectangular tank was fixed below the rotating drum of 300 litres water capacity for collecting the sprayed water from the rotating drum. The collected waste water was filtered and re-circulated with the help of a pump. The washer is designed to deliver 300 kg of vegetable per hour which are free from soil and microbial load

Cold storage

1. Low cost ripening chamber

A collapsible plastic chamber of polypropylene with a dimension of 7ft x 7 ft x 7 ft (l x b x h). Capacity - 500 to 700 kg of mango/banana/papaya fruits for use at traders level. It has four outlets at the base of the four corners which are closed tightly with a plastic string and released manually when required to have a ventilating effect inside the chamber.

2. Modernized ripening chamber

The ripening chamber has a capacity to hold and ripen 500 to 700 kg of mango/banana/papaya fruits and can be used at the traders level. A known quantity of the fruits were be exposed to the ethylene gas at different intervals and at different temperatures with different humidity levels.

Refrigerated transport

1. Refrigerated trucks

A refrigerator truck or chiller lorry is a van or truck designed to carry perishable freight at specific temperatures and commonly used for transporting fruit and vegetables, neither of which are fitted with cooling apparatus. Refrigerator trucks can be ice-cooled, equipped with any one of a variety of mechanical refrigeration systems powered by small displacement diesel engines, or utilize carbon dioxide (either as dry ice or in liquid form) as a cooling agent. Most of the long-distance refrigerated transport by truck is done in articulated trucks pulling refrigerated semi-trailers.

2. Reefer vans

Refrigerated vans are perfect for smaller businesses or temporary use when transporting anything from produce and perishable foods. The smaller size of the van provides easier access to the goods being transported unlike the large capacity of the truck.

Packaging Technologies

1. Modified Atmosphere Packaging

Modified Atmosphere Packaging (MAP) is a packaging system that involves changing the gaseous atmosphere surrounding a food product inside a pack, and employing packaging materials and formats with an appropriate level of gas barrier to maintain the changed atmosphere at an acceptable level for preservation of the food.

2. Controlled Atmosphere Packaging

Controlled Atmosphere Packaging is a method where oxygen, carbon dioxide and nitrogen are controlled and regulated. The temperature and humidity of the storage room must be regulated as well. The composition of a package's internal atmosphere is altered and oxidation is reduced.

On farm ventilation storage system for potato

On farm ventilated storage was designed for storing 400 kg of potato bulks by ventilating 4°C cold air (4 hours a day) with a 4 hours of ventilation of using 1 tonne refrigeration unit.

3. Efficient supply chain for aggregatum Onion

A forced air ventilated storage structure of 105 tones with automatic control for aggregatum onion was designed.

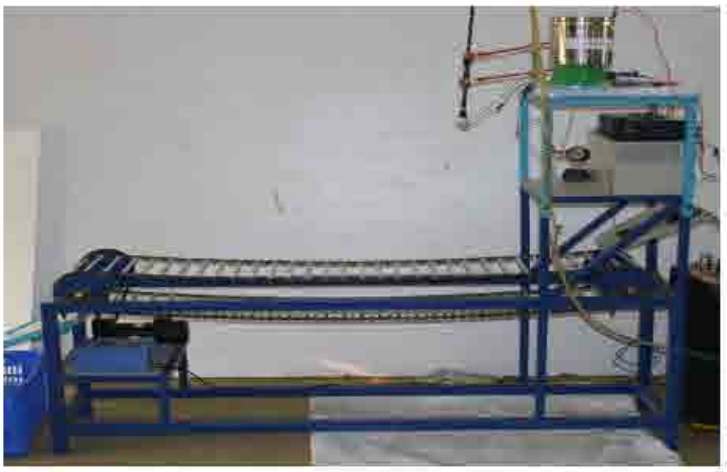
Vacuum Packaging Of Banana

Banana ripes in three to five days after harvesting. Ripening during the long distance transport and export, results in huge post-harvest losses. To delay ripening of fruits, vacuum packaging is one of the methods, where the matured banana hands are packaged and prevented from contact with air/ oxygen. Using a simple gadget for vacuum packaging, banana can be stored under vacuum. This delays ripening upto 21 days and further ripening is completed within one week after opening the package.

<u>Value addition of fruits and vegetables</u>

1. Edible coating

Edible coating solution was optimized with the natural plant extracts like *Cissus quadrangularis* to extend the shelf life of fruits. The formulated solution is coated using electrostatic sprayer operated at 4 kg/cm^2 air pressure, 20 ml/min liquid discharge and 5kV applied voltage to distribute the solution evenly.



Developed electrostatic spray coating machine

2. Waxing Unit for Fruits

Fruit waxing is the process of covering fruits (and, in some cases, vegetables) with artificial waxing material. Natural wax is removed first, usually by washing, followed be a coating of a biological or petroleum derived wax. The primary reasons for waxing are to prevent water loss (making up for the removal in washing of the natural waxes in fruits that have them, particularly citrus but also, for example, apples and thus retard shrinkage and spoilage, and to improve appearance.

3. Tomato seed extractor

Tomato seed extractor was developed to extract seeds from tomato fruits. Seeds were extracted from ripened fruits, spoiled fruits and fruits that are not harvested during glut season. The unit consists of a feed hopper, fruit crushing chamber, seed separation unit, water recycling system and seed collecting trough. The capacity of the machine is 180 kg/h with less water requirement (3 litre/min). Seed extraction is faster compared to manual method.

4. Chilli seed extractor

Chilli seed extractor is used to extract seeds from dried chilli. It consists of a hopper, extraction chamber; rotating beater assembly on bearings with suitable drive connects. The dried chilly fruits are macerated into small pieces without cell rupture and thereby the seeds are separated from the unit.

The capacity of the machine is 4 quintals/day with an operation of cost of Rs. 6/h. It is a continuous type extractor with minimal scorching and pungent smell to labourers and also the separated chilli can be utilized and ground and suitable for food purpose.

5. Brinjal seed extractor

The brinjal seed extractor is used to extract seeds from well ripe, spoiled and mature brinjal fruits. It consists of a fruit crushing chamber and a seed separation unit. In the fruit crushing chamber, radially arranged crushing rods crush the fruit into pulp with the addition of water. The pulp is conveyed to the bottom of the seed

separation unit. The good seeds settle on the sieve and collected along with water by opening the valve. The capacity of the machine is 120 kg/h with less water requirement (3 litre per minute) and the extraction of seeds of faster than the manual method.

5. Hand Operated Aonla Seed Remover

A number of processed products like aonla pulp, RTS, Nectar, squash, candy pickle, sauce and dehydrated shreds are prepared from aonla fruits. For most of the preparations seed is required to be removed from the fruit and fruits in full shape or sliced. The unit consists of a fruit-punching rod, fruit resting seat, handle with extension and the frame to hold all the important movable parts. The parts of equipment coming in contact with fruit were made out of stainless steel (Food grade) and all other parts were made of mild steel.

6. Tamarind Dehuller

The dried tamarind fruit fed through the feed hopper was subjected to the impact force from the rotating beaters. A sieve shaking mechanism was provided at the dehuller fruit outlet to remove hulls that come along with the pulp. The capacity of the dehulling machine is 100 kg/h at 10 m/s.

7. Tamarind Deseeder

Deformation of tamarind fruit caused by shear and compression of the two counter rotating differential rollers are effectively utilized to split and separate the pulp from seeds of dehulled tamarind fruit. The capacity of the deseeder is 40 kg/h with the maximum deseeding efficiency of 92 %.

POST HARVEST TECHNOLOGY OF HORTICULTURAL CROPS

Dr. P. Vennila, Professor, Centre for Post Harvest Technology,
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Horticulture plays a significant role in Indian Agriculture. It contributes 30% of GDP from 11.73% of its arable land area. India is the second largest producer of both fruits and vegetables in the world i.e. 100 Mt and 132.03 Mt respectively. A considerable amount of fruits and vegetable produced in India is lost (25 - 30%) due to improper post - harvest operations: as a result there is a considerable gap between the gross production and net availability. Post harvest losses start from the field first, after harvest, in grading and packing areas, in storage, during transportation and in wholesale and retail markets. Several losses occur because of poor facilities, lack of know - how, poor management, market dysfunction or simply the carelessness of farmers. By adopting proper post harvest handling, grading and storage practices can solve the problem for post harvest losses of perishable crops.

Post harvest technology of fruits and vegetables

Post harvest technology of fruits and vegetables involves the following process:

1. Harvesting: This is a process of gathering a commodity from the field at proper maturity level with a minimum of damage and loss. It should generally be done manually. Presently in India harvesting for potato is semi - mechanized. To avoid any physical injury or damage to the fruits etc. these be handled very carefully in plastic containers or crates for effective carriage and reducing handling losses. Careful harvesting is the key of the entire post harvest handling process. If produce incurs physical damage at harvest, there is basically nothing that the best packing, cooling or shipping can do to re - achieve that initial quality.

2. Pre - cooling: Fresh horticultural crops are living tissues and carry on the biological functions that are essential to the maintenance of life. The commodity must remain healthy and alive until processed or consumed. Process by which food reserves are converted into energy is called respiration. Product temperature at this stage is major determinant of respiratory rate. Final result of respiration is product

deterioration and senescence. It is desirable to achieve as low respiratory rate as possible. Good cooling and temperature management thus are vital practices to slowing physiological deterioration. The methods used for precooling is room cooling, forced air cooling,hydro cooling, package icing, vacuum cooling and alternative methods of cooling.

3. Preparation for fresh market: This process starts with the product harvesting. Pack house line operations generally comprise of commodity receiving, cleaning, trimming, washing, rinsing, waxing / coating, sizing and packing. These operations are undertaken mechanically and manually. Under Indian conditions these can be devised semi mechanical because of cheap, un - skilled and skilled Labour availability in desired numbers. It is desired that producing centre nearer to cold stores should form their own organizations with the participations of the local producers to add value to their crops.

4. Grading of fruits and vegetables

Grading is another unit operation in packing house. This is done by machine or manual inspection.

Manual grading: Manual grading is necessary to remove all blemished items of crops which would not normally be recognized by machine grading system. Trained graders are required to perform this highly skilled job. Sorters perform the best if they work under good lighting conditions and in comfortable working positions. Manual sorting is usually done using hand held sizing rings. Single or multiple size ring can be used for size sorting of fruits. A highly reflective or white surface are not advisable on sorting table as this causes eye strain: the eye compensates by reducing the iris so that less light is received from the fruit. Similarly, glare from fluorescent tubes should be avoided by locating the luminaries above the workers. The illumination should be uniform across the table.

Mechanical grading: Grading machines fit into four main categories depending on quality to be graded, namely, size, mass, colour and profile. Various graders working under above principles are screen grader, diverging belt grader, rotary cylinder grader, roller grader, link grader, iris grader, mass grader and colour sorter. Graders are available in several different forms, which have different numbers of contact points and different - shaped apertures. The major limitation is that most

machines are two dimensional and items may be upended to pass through. Other important aspects are gentleness to the crop, through put, capital cost of the machine and flexibility to handle a range of crops. Screen grader and roller type grader are commonly used for grading fruits and vegetables.

5. Waxing: Waxing of immature fruit vegetables such as cucumbers and summer squash: mature fruit vegetables such as eggplant, peppers and tomatoes; and fruits such as apples and peaches is common. Food grade waxes are used to replace some of the natural waxes removed in washing and cleaning operations and can help reduce water loss during handling and marketing. If produce is waxed, the wax coating must be allowed to dry thoroughly before further handling. The waxes commonly used are Paraffin wax, Carnaula wax, Bee wax, Micro crystalline waxes, Shellac waxes and Wood resins. Advantages of waxing is improved appearance, reduced moisture losses, less spoilage specially due to chilling injury and browning, protect fruits from microbiological infection, Used as carriers for sprout inhibitors, growth regulators and preservatives.

6. Hot water treatment: Crops may be immersed in hot water before storage or marketing to control diseases. Post harvest treatment with fungicide is generally reported to be ineffective in controlling the disease, but immersing them in hot water, preferably containing an appropriate fungicide, can give good disease control. The recommended condition is 51 - 55^0 C for 30 minutes for effective control of disease. A common disease of fruit which can be successfully controlled by this way is anthracnose caused by infections of the fungus Colletotrichum spp

7. Ionizing irradiation: Irradiation of food is one of the useful methods developed during last three decades. One of the significant advantages of ionizing radiation is that it can destroy pathogenic organisms without appreciably raising temperature of produce, though it involves high initial capital involvement. The radurisation (pasteurization with ionizing radiations) is being well accepted due to its easy application. It leaves no potential residue and needs minimal energy expenditure. Ionizing radiation extends storage life of perishables through its action as surface pasteurization, sprout inhibition and retardation of senescence process.

Ripening mangoes can be delayed by application of ionizing irradiation. Irradiation with 25 -35 k rads is also useful to delay initiation of natural ripening of banana without interfering with ethylene induced ripening or affecting quality of the

fruit. Ionizing irradiation also inhibits sprouting of potatoes, onions and other bulbs most effectively at 10-15 k rads.

8. Packaging: Packaging is an integral part of fruit and vegetable processing. It has major influence on storage life and on marketability of fresh as well as processed products. Packaging fulfills several functions including containment, facilitating transportation, production of fruit / vegetable from further damage, protection of environment from contents of package(for example if the contents are dirty), marketing, product advertising and stock control.

Main factors that cause deterioration of product during storage are as follows: mechanical force (impact, vibration, compression etc), climatic influences that cause physical or chemical changes (UV light, moisture, oxygen, temperature changes), contamination (by microorganisms, insects or soil) and pilferage, tampering or adulteration. Packaging provides a barrier between food and environment. It controls moisture and gases, movement of microorganisms/ insects, mechanical strength, light transmission and transfer of heat.

The requirements of packaging materials are:

- They must be non toxic and compatible with specific food
- Sanitary protection and light protection
- Ease of opening and ease of disposal
- It should have pouring features and reseal features
- Size, shape and weight should be convenient for consumer handling
- Attractive and ease of printability
- Smooth, efficient and economical operation on production line.
- Resistance to breakage(eg. Fractures, tears or dents caused by filling and closing equipment, loading / unloading or transportation)
- Low cost and other special features related to consumer and retailer.

Packaging systems

Packaging system is categorized as : primary packaging, secondary packaging, distribution or tertiary packaging, and unit load.

Primary packaging

The first-level package that directly contacts the product is referred to as the primarypackage."For example, a beverage can or a jar, a paper envelope for a tea bag, an inner bag in a cereal box, and an individual candy wrap in a pouch are primary packages, and their main function is to contain and preserve the product Primary packages must be non-toxic and compatible with the food and should not cause any changes in food attributes such as color changes and undesired chemical reactions.

Secondary packaging

The secondary package contains two or more primary packages and protects the primary packages from damage during shipment and storage. Secondary packages are also used to prevent dirt and contaminants from soiling the primary packages; they also unitize groups of primary packages. A shrink wrap and a plastic ring connector that bundles two or more cans together to enhance ease of handling are examples of secondary packages.

Tertiary package

The tertiary package is the shipping container, which typically contains a number of the primary or secondary packages. It is also referred to as the distribution package."A corrugated box is by far the most common form of tertiary package. Its main function is to protect the product during distribution and to provide for efficient handling

Functions / Purpose / Importance

- To protect the food product.
- To keep it in good condition (Hygienic condition).
- To preserve the flavor until it reaches the consumer.
- Protecting the product from thermal changes, humidity and water vapour.
- Barrier protection. Containment and Information transmission.
- Marketing. Safety and Security. Convenience and Ease of communication.

Types of packaging materialPaper and paperboard

These include paper wrappers, sacks & label, fibre board cases, boxes, folding cartons, paper and carrier bags. Solid & corrugated fiber board cases are probably the most widely used convenient & economical higher than 100kg at weight. They are light in weight can be eerily manufactured printed & stored and may be closed successfully with adhesives gummed paper tape self adhesive plastic tape and stapling.

Metal

It is used for packaging in the form of tin plated steel cans and boxes. Tin plate is durable & highly resistant to chemical & mechanical damage. Tin plate retail containers are divided into two classes Cylindrical and Open top variety. Line cans that have replaceable lids 80 to 90% of the cylindrical open top types are use for food packaging. The modern tin can, composed to 98.5 percent sheet steel with a thin coating of tin and manufactured on high speed automatic machinery is the cheapest and most serviceable container for mass products. Metal is used are aluminium foil aerosols, steel drums, boxes and crates.

Plastics

The flexible packaging material commonly used are polyethylene, polystyrene, polyvinyl chloride, polypropylene, polyethylene tetra thalate and HDPE & LDPE. Polythene used is in the form of film and much is converted into shrink film, lines, sacks and bags. Some plastics are used inthe form of bottles, containers, coatings and laminates. Polyvinyl chloride is used typically for soft drinks, cooking oil and vinegar bottles, chocolate covers. Polystyrene is principally made into tubs for ice cream packs for eggs & sausages & small pots or jars for butter, jam & cheese. Polypropylene is growing rapidly, especially as a transparent overwrap.

Wood

Boxes, crates, casks, kegs, pallets & few other types of containers made of wood are usedon a limited scale to package food product. Timber cases and crates are used extensively for weight above 100kg.Timber is also used for casks for wine & beer.

Glass

Glass is highly inert material of great cleanliness. Containers made of glass are durable, chemical resistant. Ideal for the storage of solid and liquid foods. Glass is easily formed into almostany shape and has exceptional aesthetic potential. Glass containers both bottles & jars are easily mass produced and can be reused. Most are good barriers to moisture and moisture vapour; some are good barriers to Oxygen and other atmopheric gases.

Packaging Technologies for fresh produce

Storing at low temperature – cold storage, Modified Atmosphere Packaging (MAP), Controlled Modified Atmosphere Packaging (CMAP), freezing are adopted to reduce the respiratory rate, transportation loss and to minimize metabolic changes that occur in the fruits and vegetables after harvesting. Various packaging technologies are followed which in turn adds valueto the fresh produce too. Minimal processed products offer a number of advantages as per packing allows for more efficient portion control. Solid waste disposal problems and demand on storage under refrigeration are reduced. Supply of a variety of ready to eat items that exhibit excellent uniformity of quality and identity is available over many weeks. It has been known for over a century that the shelf-life of some foods can be extended by storage in gas environments different from that which is normally observed in the earth's atmosphere (i.e. 78.08 vol% N_2, 20.95 vol% O_2).. The storage of apples and pears in warehouses under reduced O_2 and elevated CO_2 conditions was also first exploited in the 1930's where it was shown to double the shelf-life of produce. Controlled Atmosphere (CA) storage is the term commonly applied to these mobile or large-scale fixed enclosures in which gas concentrations are maintained via various mechanical systems.

MAP works on the principle of providing the ideal storage micro-atmosphere to packaged food in conjunction with or without other techniques. Fresh fruits and vegetables, meats, poultry and fish for instance require MAP with low temperature storage to maintain good quality with reasonable shelf life. The gas atmosphere surrounding a particular food product can be altered to retard chemical and metabolic processes that are detrimental to product quality or to inhibit the growth of undesirable microbial populations. The optimal gas atmosphere inside the package depends on the composition of the contained food and the microbial contaminants that could potentially be present.

MODERN PACKAGING CONCEPTS

Packaging, like food processing, is a multi-disciplinary subject and considerable research goes into it. As a result, the packaging scenario in the commercial food business undergoes periodic upheavals causing the packaged product quality to improve accompanied normally by lower costs and better product handling convenience. Some of the more recent packaging systems and concepts are "Form, Fill and Seal (FFS)" system, aseptic packaging system, retortable pouches, Modified Atmospheric Packaging (MAP), active packaging systems and intelligent packaging systems. Some of these will be described briefly below:

Form, Fill and Seal System

FFS system is one in which the processed food product stored in a tank is continuously fed to the packaging system and gets packaged as pouch or a semi-rigid rectangular pack. This system is suitable for liquids and/or free-flowing solids only. In this the packaging material is purchased in the form of rolls. The machine unwinds the roll, sterilizes it by hydrogen peroxide or UV light, forms into a tube and then seals one end of it. The product is filled into this through a measuring mechanism and then the top end of the tube is sealed thereby hermetically sealing the product. The top sealing, which also acts as the bottom seal for the next package can be accompanied by a cutting action if so desired by the packer. This machine can pack 30-35 units per minute and have revolutionized the pasteurized milk packaging in the dairy industry and spices, ready mixes, etc. in other food industries.

Aseptic Packaging Systems

Aseptic packaging is a relatively new packaging concept aimed at developing new product group, namely pre-sterilized and aseptically packaged foods. During aseptic packaging process, a pre-sterilized product is filled under sterile conditions into sterile packages in a sterile environment and then germproof sealed.

Although both the aseptic can filling and aseptic carton filling systems became commercial during the late fifties and early sixties, only the latter found application in aseptic packaging of liquid foods, more particularly Ultra High Temperature milk and fruit juices. During the past few years, environmental considerations have led to the use of recyclable glass bottles instead of cartons in countries like Germany. Aseptic barriers in the form of steam or circulated liquid sterilant become necessary with

valves and fittings coming in contact with sterile milk. Detection of leaks by using a dye test is imperative to check recontamination of the packaged sterile milk.

Retort Packaging for Long Shelf-life Foods

The concept of retort pouch which took shape in the 1940's, was developed again in response to the military need, as the rigid cans conventionally used by the combat forces posed problems such as difficulty in opening, injurious, and the potential to be used in makeshift explosives by the enemy. The retortable flexible packages are characterized by their structural components of heat resistant plastic layers with or without aluminium foil and their ability to be thermo processed to result in shelf-stable food product. Its cost is also less as compared to cans. An early pioneer in proving the production reliability of the retort pouch was the US Army Natick Research and Development Center. In many developed countries, most ready-to-eat foods are packaged in retort pouches. Japan has been a pioneering country in this aspect. In most recent times, focus has shifted to retortable semi-rigid trays or tubs because of their added convenience in use.

ACTIVE AND INTELLIGENT PACKAGING

Active packaging techniques for preservation and improving quality and safety of foods can be divided into three categories: absorbers (i.e. scavengers), releasing systems and other systems. Absorbing (scavenging) systems remove undesired compounds such as oxygen, carbon dioxide, ethylene, excessive water, taints and other specific compounds. Releasing systems actively add or emit compounds to the packaged food or into the head-space of the package such as carbon dioxide, antioxidants and preservatives. Other systems may have miscellaneous tasks, such as self-heating, self-cooling and preservation.

NOVEL PACKAGING TECHNIQUES

Edible Packaging

Edible films and coatings are based on proteins, polysaccharides and/or lipids have much potential for increasing food quality and reducing food-packaging requirements. Edible films formed as coating or placed between food components provide possibilities for improving the quality of heterogeneous foods by limiting the migration of moisture, lipids, flavour/aromas, and colours between food components. Edible coatings also have the potential for maintaining the quality of foods even after

the packaging is opened. In addition, edible films formed as coatings on foods could have an impact on overall packaging requirements. Edible coatings also have the potential for carrying food ingredients and improving the mechanical integrity or handling characteristics of the food.

Materials for Edible Films

a)Protein: There are different proteins like milk protein, wheat gluten, corn protein, soy protein, etc. that are used for film formation. Manufacture of edible films and coatings are from whey protein products, represent an effective means of increasing excess whey utilization consequently alleviating the whey disposal problem.(b) Polysaccharide: Polysaccharides that have been used for film forming are cellulose and cellulose derivatives, starch, some hydrocolloids like carrageenan, pectin, etc. polysaccharides films have poor moisture barrier but have good mechanical properties.(c) Lipid: Lipids like bee waxes, rice bran, paraffin wax, acetylated monoglycerides, etc. have been used for film making. Wax has been used for coating of cheese, fruit, etc. Lipids are hydrophobic and therefore act as a good moisture barriers, however, their mechanical properties are inferior to proteins and polysaccharide based films.(d) Composite films: composite films consist of two or more components so that characteristics of the film are enhanced by individual contribution from each component, e.g. protein and polysaccharide films by themselves are fairly hydrophilic but have very good mechanical properties.

BIO-DEGRADABLE PLASTIC

Biopolymers or bioplastics are intrinsically biodegradable and their use would reduce the damage inflicted to the environment by petrochemical plastics due to their extended lifetime in the environment. They are polymers utilized by bacteria as carbon and energy reserve material and accumulated by them when other essential nutrients are depleted from the medium. Plant derived starches has been used to produce biodegradable plastic articles viz. Pharmaceutical capsule by blow molding process. Further sources of biodegradable materials are poly lactic acid, poly malic acid, or poly E-caprolactones, which are synthesized chemically. In contrast, poly B-hydroxy alkanoates (PHAs) are produced microbially from renewable, plant-derived feedstock.

Nano packaging

Nano packaging has number of benefits It offers Innovative, improved, Smart, and 'Intelligent' packaging which may enhance food safety and hygiene in the supply chain; reduce food waste by extending shelflife of food products and improve performance Nanomaterials are being developed with enhanced mechanical and thermal properties to ensure better protection of foods from exterior mechanical, thermal, chemical, or microbiological effects. Nanocomposites, for instance, are nanoparticles bonded in polymers so that the materials have enhanced properties such a lighter weight and better recyclability, as well as spoilage and flavor issues. A nanocomposite materials are currently being used in beer bottles; allowing for a 6 month shelf life. A nanolaminate consists of 2 or more layers of materials with nanometer dimensions that are physically or chemically bonded to each other. A variety of different adsorbing substances could be used to createthe different layers, including natural poly electrolytes (proteins, polysaccharides),charged lipids (phospholipids, surfactants), and colloidal particles (micelles, vesicles, droplets). It would be possible to incorporate active functional agents such as antimicrobials, anti browning agents, antioxidants, enzymes, flavors and colors into the films. These functional agents would increase theshelf life and quality of coated foods.

Package printing methods and security: The use of printing inks in food packaging falls under the jurisdiction of the Food and Drug Administration (FDA). The regulations in effect require that the ink materials be manufactured under safe conditions. It is recommended that the ink be composed of organic compounds. Rubber plates with a raised image area are printed with quick- drying inks directly on foil, plastic wrap and other material. The typical composition of inks consists of colorants, binders, and carriers, depending upon the application. High quality inks and varnishes address many technical expectations including specific resistance, curing time, safety andsustainable environmental requirements. Flexography printing process is appropriate for plastic- based cartons, and wrappers. Lithographic printing permits the reproduction and printing of finer screen rulings and photographic images. The electron Beam (EB) printing procedure facilitates the coating and drying of adhesives without heat or light, Processors and suppliers adopt a variety of techniques to keep food safe .

9. Transportation: Transportation and distribution of fruits and vegetables are important stages of post harvest losses. In India, transportation of perishable commodities is in the most precarious stage. For local market, the produce is brought either by bullock cart or tractor trollies. The long distance transportation is mainly by rails and trucks. Transportation methods used for moving fresh horticultural crops include road, rail, ship, airplanes and a combination of these. The tips for efficient transportation are as follows:

- The vehicles should not be overloaded. The compression damage to produce can be prevented by avoiding over - filling of containers and stacking heavier produce at bottom load. The vehicle should also have adequate ventilation to prevent heat gain during transport.
- Strong packages may be used to reduce mechanical damages. Also rough handling should be avoided during loading and unloading.
- During stacking of containers, try to align them properly. A 3 cm overhang will decrease stacking strength by 15 to 34 %.
- The vibration damage can be prevented by using air suspension systems. This provides a gentler ride during transportation. Use of suitable trays, place of packaging, use of plastic bags, container liners or placing a soft pad at the top of a full box can also reduce vibration damage considerably.
- For transporting of open loads a thick layer of insulation and cushioning may be provided for bulk loads. Packed produce may be loaded in uniform stacks, braced securely to prevent damage. Other loads should not be placed on top of a bulk - loaded commodity.
- A wind catcher may be designed such that a free air movement is possible into vehicle during transport. Also channels may be provided for passive air movement beneath and up through load. Proper shading should be provided for load with a silver or light coloured canvas cover.
- In case of refrigerated transportation, ensure that vehicles are well insulated and have doors that seal tightly and securely. The refrigeration unit should not turn off during delays in transport.

- Load only pre cooled produce into vehicles. Also pre cool the refrigerated vehicles to suit produce requirements. The delays during loading should be avoided as this cause heat gain, especially if produce are exposed to full sun.
- Use high quality vented containers and load produce to ensure adequate air movement through the load to remove heat generated by produce respiration. A free movement of air flow should be provided within the load.
- Monitor supply air temperature and return air temperature for obtaining the beast performance of refrigeration units. A portable temperature recorder may be used to verify temperature management during transport.
- Avoid mixed loads if possible; or install ethylene scrubbers to prevent damage to ethylene sensitive commodities.

Fruits and vegetables are commonly transported by using Fruits Cold storage vehicle, Mobile cool chamber, Refrigerated Truck with Air Circulation System and Multi temperature refrigerated truck.

10. Storage practices for fruits and vegetables

It is one of the most important aspects of the post harvest handling of the fruit and vegetables. The main objectives of storage are a) to reduce physiological activity of horticultural crops, b) to reduce the growth of microorganisms and c) to prevent drying of fruits and vegetables. Storage practices for fruits and vegetables in India are as follows:

Traditional storages: The types of simple traditional stores include:

a. On site storage: On site (in situ storage) means delaying harvest until crop is required. It can be done in certain cases with root crops, however, the land where the crop was grown remains occupied and a new crop cannot be planted there.

b. Pit storage: Pits or trenches are dug at edges of field where crop has been grown. If the field slopes, it is important that pits or trenches are placed at a high point in field, especially in regions of high rain fall. Pit or trench may be lined with straw or other organic material, filled with crop to be stored, covered with a layer of organic material and then a layer of soil. Ventilation holes may also be left at the top covered with straw in such a way as to allow air to pass out but no rain to penetrate.

c. High altitude cooling: High altitude can also be a source of cold for storage of perishables. As a thump rule air temperature decreases by 10 ◦c for every 1 km increase in altitude. The advantage of this low temperature can be utilized for the storage of horticultural commodities at high elevation in mountains.

d. Clamp storage: Clamps are suitable for storing potatoes, turnips, beetroot and cassava.

e. Cellar / underground storages: These are usually constructed beneath the house. Their temperature is approximately equal to average annual air temperature. This location provides good insulation, which means they cool warm ambient conditions and protect from excessively low temperatures in cold climates. They are usually used for storing crops such as apples, cabbages, onions and potatoes during winter. Crops are usually spread out thinly on shelves to ensure good air circulation.

f. Evaporative cool storage: The evaporative cooler works on principle of latent heat of vaporization of water. When water evaporates from liquid to vapour phase, it requires energy. Heat energy from atmosphere is taken for evaporation of water and this makes storage atmosphere cool. Degree of cooling depends on original humidity of air and efficiency of evaporating surface. A low relative humidity provides better cooling effect in evaporative cool storage.

There are two methods of evaporative cooling: active method and passive method. In active method, air is drawn to the storage structure using a fan. This method is more efficient compared to passive / natural method, but requires electrical energy. Hence, air is cooled by passing through wet pad before it passes through packages and around the produce. Air can be cooled to within a few degrees of wet bulb temperature of ambient air. In case passive method, natural or prevailing wind is utilized for air movement.

Improved storage methods: There are many improved methods practiced for safe storage of fruits and vegetables. Underlying principle of each method is briefed below:

a. Cold storage: In the cold storage, the temperature control is very important. The temperature is brought down by taking out the heat with the help of mechanical refrigeration. The ideal environmental condition for fresh produce in storage is the lowest temperature which does not cause chilling injury to the produce. Relative humidity of the storage rooms also has considerable bearing on the keeping quality of horticultural commodities.

b. Modified Atmosphere Packaging: Modified Atmosphere Packaging (MAP) is defined as "Packaging of a perishable product in an atmosphere which has been modified so that its composition is other than that of air". The modified atmosphere surrounding the produce brings about beneficial effects, for extending shelf life of product. Mixture is made up primarily of O_2, CO_2 and N_2 with perhaps small amounts of noble gases. The expected benefits of MAP are:

- Reduction of respiration rate and ethylene production
- Inhibition of ripening and senescence
- Minimization of water loss and nutrient decomposition
- Inhibition of microbial growth, physiological disorders and spoilage.
- Extension of shelf life with retention of quality attributes.

c. Controlled Atmosphere Packaging: Controlled Atmosphere (CA) storage is a process of introducing a specific MA around fresh produce and maintaining the specific composition within a sealed storage chamber during designated storage period. In CA, atmospheric components are precisely adjusted to specific concentrations; however in MA, no effort is made for controlling atmospheric components at specific concentration once package has been hermetically sealed. For most of the fresh commodities, low temperature, high relative humidity, low O_2 concentration and high CO_2 concentration need to be maintained to minimize metabolic activities of stored commodities.

CA storage is used for ware house storage of whole fruit and vegetables or bulk controlled atmosphere road or sea - freight transport of perishable foods. Because of continually controlled storage environment with respect to temperature, RH, and type of gas atmosphere, operational and maintenance were increased. Hence the technique becomes uneconomical with most of perishables.

d. Hypobaric storage: Hypobaric or low pressure storage is another form of modified atmosphere or controlled atmosphere storage in which pressure, temperature and humidity are accurately controlled. In addition to these three factors, in hypobaric storage, the rate at which the air is changed in storage environment is closely regulated. By reducing normal atmospheric pressure in the

environment surrounding the commodity, effective partial pressures of individual gases present are also lowered. For example, a one - fifth reduction in total pressure of normal air would result in effective oxygen partial pressure equivalent of 4%.

Conclusion: Fruits and vegetables are perishable in nature. Scientific harvesting and handling are the practical way to reduce the losses due to physical damage, spoilages, due to insect damages and microbial growth. Various protocols are standardized and available for adoption to get the best result, which will give economic benefits. Similarly, proper storage conditions, with suitable temperature and humidity are needed to lengthen the storage life and maintain quality once the crop has been cooled to the optimum storage temperature. Greater emphasis need to be given on the training of farmers, creation of infrastructure for cold chain with common facilities for sorting, grading, packing and post harvest treatments in all major markets. Some technologies for extension of shelf life of fruits and vegetables are: waxing, evaporative cool storage, pre- packaging, cold storage, modified atmospheric packaging, controlled atmospheric storage, cold chain, irradiation and edible coating.

PROCESSING AND PRESERVATION OF FRUITS AND VEGETABLES

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Introduction

India is a land of large varieties of fruits and vegetables due to its vast soil and climatic diversity. It has been classified into tropical, sub tropical and temperate regions, each region conducive for definite types of fruits and vegetables, and the climatic diversity maintains the inflow of almost all varieties throughout the year.

India ranks second largest producer of fruits and vegetables next to Brazil and China respectively. There exists wide gap between availability and the per capita nutritional requirement of fruits. As per ICMR recommendation, 92g of fruits are to be consumed daily by one person whereas, only 46g are available. The low availability of fruits is mainly due to the considerable high post harvest losses, poor transportation facilities, improper storage and low processing capacity coupled with a growing population. Around 20-30% losses take place during harvesting, grading, packaging, transportation and marketing of fruits.

India's major exports are fruit pulps, pickles, chutneys, canned fruits and vegetables, concentrated pulps and juices, dehydrated vegetables, and frozen fruits and vegetables. The installed capacity for fruit and vegetable processing has doubled in six years, and the average annual growth of production of processed fruits and vegetables during this period has been about 22%.

1.Processing and Preservation Technologies for Enhancing the Shelf life

Minimal processing of fruits and vegetables

Minimally processed operations have been defined as, those procedures such as washing, sorting, trimming, peeling, slicing, chopping, anti-oxidants treatments and packing etc. that do not affect the fresh like quality of fruits & vegetables. The minimally processed fruits & vegetables are the products that are partially prepared so that no additional preparation is required for their use. The result of such operation is that the products can be prepared and consumed straightway in very short time.

Microwave processing

The increasing consumer demands for foods which offer more convenience in usage andtime savings in preparation made microwave oven as an alternative for conventional thermal ovens.

The microwave processing has been made use of for drying of fruit juices, pulps, apple segments and finished drying of potato chips. Microwaves are endowed with some special characteristics such as, high penetrating quality which results in the uniform heating of materials, selective absorption of radiation by liquid water and capacity for easy control. These impart some unique effects to the dehydrated material such as improved quality and good texture. In the wider field of preservation, microwaves have been used in drying, blanching and vacuum drying. Typical product areas where microwaves have been used commercially include blanching of vegetables, where it is claimed that there is less need for mechanical handling with consequent better product. Also, microwaves in combination with hot air have been shown to be a positive route to drying of foodstuffs, in selective product areas, where, other methods cannot be employed. Finally, microwave vacuum drying has found some outlets in producing fruit juices.

The aim of using microwave processing in preservation in general and pasteurization or sterilization in particular is to deliver a more homogeneous heat treatment at a faster rate than conventional method of heating.

Radiation processing

Radiation processing of food involves exposure of food to short wave energy to achieve a specific purpose such as extension of shelf life, insect disinfestations and elimination of food borne pathogens and parasites. In comparison with heat or chemical treatment, irradiation is considered a more effective and appropriate technology to destroy food borne pathogens. It offers a number of advantages to producers, processors, retailers and consumers. Food irradiation can be used on most fruits and vegetables, as well as meat, poultry, seafood like fish and shellfish, spices, potatoes, grains and a host of other commodities

Irradiation is a cold process and can be used to pasteurize and sterilize foods without causing changes in freshness and texture of food unlike heat. Unlike chemical fumigants, irradiation doesnot leave any harmful toxic residues in food and is more effective. It is efficient and can be used to treat prepacked commodities.

India is the largest producer of fruits. Mango, banana, citrus, guava and apple account for 70% of the total fruit production. Fruits on ripening acquire the appropriate colour, texture, aroma and flavor and thus become edible. However, a ripened fruit has a limited shelf life and spoils within few days. Transportation of ripe fruits having soft and delicate texture also posses problems. India is also known for its very high post-harvest losses thus squandering the benefits of high horticultural produce. Further, increase in production resulted by modern agricultural practices provided much higher availability of fresh fruits ultimately ending up at enhanced post-harvest losses. Thus development of technologies for the prevention of post-harvest losses demands maximum attention. Radiation processing may find applications in extending shelf life of fruits by delay in ripening thus reducing losses during transportation. It may also decontaminate microorganisms and eliminate insect pests from fruits. Elimination of insect pest like seed weevil from horticulture produce is essential to boost international trade. Thus there is an imperative need to develop post-harvest biotechnology in India so that wastage can be minimised. The need of the hour therefore is to extend shelf life of fresh produces and value addition by developing new products of commercial importance.

Fruits belonging to the climacteric class such as bananas, mangoes, apple, papaya, guava, tomato, plum etc. when subjected to a judicious dose of γ–rays delayed the ripening process. To obtain the best result it is important to irradiate the fruits at pre-climacteric stage. No delay in ripening is observed in fruits of non-climacteric class such as grapes, lemon, oranges, cashew apple, pineapple, cherry, cucumber etc. but could achieve an extended shelf life by microbial decontamination of the fruits. Another major advantage of γ–irradiation is the control of fruit weevil, which as a quarantine process that could boost exports of some fruits and vegetables.

Ohmic heating

Electrical resistance heating allows particles and liquids to heat at the same rate and permits the rapid heating of mixtures of high solids fractions. The technique has been applied to a number of food processes, and has recently been developed into a commercial process for the sterilization of food mixtures. Ohmic heating occurs, when an electric current is passed through an electrically conducive product. Low frequency current from domestic supply could be effectively used for ohmic heating.

The ohmic heating has many advantages over conventional heating. Continuous processing is possible without any heat transfer surface. Liquid-solid mixture can be rapidly and evenly heatedwith minimal heat damage and residence time difference. Nutrient retention will also be more. This process can obtain fresher-tasting, high quality products with high microbiological safety. Maintenance cost is minimum due to absence of any moving parts. The process is easy to control. Ambient temperature storage and distribution is possible when combined with an aseptic filling system.

High-voltage pulse techniques

The application of homogenous and no homogenous, pulsating, electrical fields with high field strengths for killing microorganisms can be, in competition with the conventional thermal process, a method for pasteurizing pumpable food material by itself or in a medium.

In particular the application of homogenous fields at low treatment temperatures has proved to be a product-saving sterilization process in various natural systems, mainly juices.

However when designing plants for large scale production, it is essential that preliminary batch tests are carried out on a small scale. This requirement is based on the experience that the mortality of a certain species of microorganisms is very dependent on the nature of the suspension medium.

High Pressure Processing (HPP)

Hydrostatic pressure technology is a novel, non-thermal food processing technology whereby foods are subjected to high hydrostatic pressure, generally in the range of 100 - 600 MPa, at or around room temperature. In general high pressure technology can replace or supplement conventional thermal processing for reducing microbial load and changing theology and also replace chemical preservatives which do not satisfy consumer acceptance.

Just as high temperature inactivates microorganisms, so High Hydrostatic Pressure (HHP), whether or not in combination with moderately elevated or reduced temperature, inactivates vegetative microorganisms, spores and enzymes and, as such, allows one to achieve increase in the shelf-life of foods. Since HHP denatures proteins and polysaccharides, the technology also presents interesting applications

in the area of food texturization. In both areas, preservation and texturization, the non-thermal character of the technology opens up unique opportunities to the food industry for the development of novel foods of superior nutritional and sensory quality, novel texture, more convenience, higher safety with increased shelf life at condition chilled or ambient.

In view of the present cost of the technology and its limitations in terms of capacity, it is undoubtedly true to state that HHP will not replace conventional preservation and processing technologies for high volume, foods in the near future. However, HHP is expected to offer commercially feasible alternatives to conventional technologies and find its niche applications in the growing market of high quality, high priced foods. The most difficult challenge of the commercial application of high pressure food processing probably lies in the uncertain field of marketing. i.e., identifying those niche applications for which the higher high pressure processing cost is justified by superior or unique product properties.

Dehydration processes for fruits and vegetables

Fruits and vegetables, which are sensitive, have to be dried under controlled conditions. Prolonged heat treatments result in the loss of delicate flavour, decrease in nutritional quality and acceptability of the product. A constant search is being made to develop new processes to remove the water. In addition, the emphasis on efficient use of energy in recent years has brought out the improvement of the product and lowering the cost of operation. A variety of processes are now at disposal of the Food Technologists for this purpose.

Osmotic dehydration

It is a two stage dehydration process, wherein fruits and vegetables are initially dehydrated osmotically by immersion in concentrated sugar syrup / salt solution which removes 35-45% of water during osmosis after which the fruit / vegetable pieces are drained and dried further in air or vacuum drier. Sugar syrup protects colour and flavour during this process. The principle used in this process is that water diffuses from dilute solution to concentrated solution (hypertonic solution) through a semipermeable membrane until concentration equilibrium is reached. The driving force is the water activity gradient caused due to the osmotic pressure. This technique can be used to remove water from cellular materials such as fruits

and vegetables. The cell membrane of these materials is semipermeable in nature and is more selective for water and acid than solute. Thewater and acid diffuse at faster rate initially and slow down later, while solute from concentrated solution diffuses in opposite direction. Type of osmotic agent, concentration, temperature, agitation of syrup, size of the fruit pieces, and fruit to syrup ratio are some of the factors whichaffect the osmotic dehydration.

Syrup concentration of about 70 degree Brix and working temperature of around 50C were found to be the most favourable for apple and other fruit pieces. Osmotic dehydration should result in 70% original weight reduction without further processing to be economical for commercial production. It was concluded from osmotic dehydration of mango and banana that the economics of the process probably depends on the availability of sugar at cheaper cost, reuse of syrup and finally disposing of spent syrup in canning or soft drink plant.

Foam-mat drying

It is a novel method of dehydration, highly suitable for fruit juices, heat sensitive products, high quality instant foods and other dry sticky and viscous materials. In this method, a liquid concentrate along with a stabilizer is subjected to dehydration in the form of a mat of foam. In this method, temperature involved is relatively low. Foam mat drying rates are comparatively very high because of an enormous increase in the liquid gas interface, in spite of the fact that the heat transfer is impeded by a large volume of gas present in the foamed mass. Foam mat drying is carried out in four steps.

(i) Pretreatment of the materials and preparation of liquid concentrate

(ii) Preparation of stable foam and spreading it out as a mat

(iii) Drying and

(iv) Evaluation, treatment and packaging of the dried product.

The key step in foam mat drying is the preparation of stable foam, which is stable for two to three hours with minimum amount of drainage at about 50 C. To facilitate the formation and stability of foam, the presence of foaming agent and stablizer, is essential.

Quick freezing

In a tropical country like India with varying climatic conditions and seasons of gluts and scarcity, refrigeration has a very important role to play in the preservation of perishable food materials. Freezing of foods is well recognized as the best method of preservation by which the quality of frozen material remains very similar to that of fresh ones. Besides, frozen foods have better nutritive value, better flavour and better colour and appearance than the corresponding foods preserved by any other method of processing. Their growing popularity is due to the fact that their quality is considered to be far superior to that of the similar foods preserved by other conventional methods of preservation like canning, dehydration etc.

There appears to be tremendous scope for development of frozen food industry in India. Through the systematic development of cold chain for bulk and retail marketing one could visualize ample opportunities in frozen foods as convenience foods and notably in frozen ready to serve meals. In fact frozen foods including frozen cooked ready to serve meal (heat and serve) have become so popular in most of the developed countries that the frozen foods have come to the top superseding the canning and dehydration industries which are now almost at the bottom of the food industries.

Membrane process technology

Membrane separation processes are based on the ability of semi permeable membranes of appropriate physical and chemical nature to discriminate between molecules primarily on the basis of size, and to a lesser extent, on shape and chemical composition. Depending on the chemical/physical properties of the membrane (primarily pore size distribution), concentration or dewatering (reverse osmosis, RO), fractionation of components in solution (ultrafiltration,UF) and clarification of slurries or removal of suspended matter (microfiltration MF) are accomplished.

Membranes are commercially available, but all of them are not suitable for food application. Cellulose acetate and derivatives are still the most widely used despite their limitations. Thin-film composite membranes containing a polyamide separating barrier on a polysulfone or polyethylene supporting layer, generally give better performance for RO applications with regard to temperature, pH stability and

cleanability but have almost zero chlorine resistance. Polysulfone is practically in a class by itself for UF. On the other hand, MF membranes are available in a wide range of natural and synthetic polymers and inorganic materials.

Processing of fruit juices and other beverages may become an area for large scale application of membrane technology in the future. UF is ideal for clarification of juices, replacing the conventional holding, filtration, decantation and perhaps the final pasteurization. Higher yields, improved juice quality due to removal of pectins, polyphenol oxidase and tannin-protein complexes and elimination of filter-aid and finding are its desirable features.

Other food applications with major potential include, production of concentrates and isolates from oilseed and legume proteins, removal of glucose and partial concentration of egg melange prior to dehydration, concentration of blood and gelatin, purification and pre-concentration of sugar, removal of yeast from alcoholic distillery process streams by MF or UF instead of centrifuge or filters, and concentration of orange juice by RO.

2.Conclusion

Though different new technologies have been advocated for food processing, one technology (or) combination of technologies suitable for a particular food to be processed/preserved has/have to be identified experimentally and then strictly adopted for the production/preservation of quality food. This food processing operation reduces the post harvest losses but also increases the shelf life of fresh food material or value added food products produced out of it. In turn, products with increased shelf life will increase the availability of the same in the market for longer time and thereby stabilize the price in the market and meet the consumer requirements. Reduction in loss and increase in the availability of food, will finally reduce the millions of population in hungry, present in our country. Finally processed food free from contamination will definitely increase the general health of the consumer.

VALUE ADDITION OF FRUITS AND VEGETABLES

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There is a big challenge to the post-harvest scientists and entrepreneurs to create the domestic demand of processed vegetable products in large middle income families of our societies. Low cost vegetable processing technologies coupled with maintenance of aesthetic and sensory quality can create demand of processed vegetables in domestic markets. The supply of processed vegetables should be ensured during off season production.

Table 1: Composition of some tropical fruits (per 100 g if edible portion)

Fruits	Edible portion (%)	Moisture (%)	Protein (g)	Fat (g)	Minerals (g)	Fiber (g)	Carbo-hydrates (g)	Carotene (g)	Vitamin (mg)
Aonla	89	81.8	0.5	0.1	0.5	3.4	13.7	9	600
Bael	64	61.5	1.8	0.3	1.7	2.9	31.8	55	8
Custard apple	45	70.5	1.6	0.4	0.9	3.1	23.5	-	37
Jackfruit	30	76.2	1.9	0.1	0.9	1.1	19.8	175	7
Guava	100	81.7	0.9	0.3	0.7	5.2	11.2	0	212
Jamun	75	83.7	0.7	0.3	0.4	0.9	14.0	48	18
Mango	74	81.0	0.6	0.4	0.4	0.7	16.9	2743	16
Sapota	83	73.7	0.7	1.1	0.5	2.6	21.4	97	6

Source: Gopalan et al., (1978)

Methods of processing of fruits into products:

- Preservation by heat treatment.
- Asceptic packaging.
- Preservation of by removal of heat.
- Quick freezing.
- Preservation by removal of moisture.
- Preservation by addition of chemicals.
- Minimal processing.

Mango (*Mangifera indica*)

Mango is one such fruit, which can be processed at almost every stage of growth, development, maturity and ripening. Raw mango fruits are utilized for mango powder, pickle, chutney etc. An excellent drink can also be made from green mangoes. Ripe mangoes are utilized for making slab, toffee various beverages such as nectar, squash etc. Drying after exposing to sulphur fumes also preserves ripe mango slices.

Guava (*Psidium guajava*)

Guava is very popular as a fresh fruit because of its excellent taste, high vitamin content and 100% edibility. This fruit is equally important for the processing industry. A large number of processed products are manufactured from guava. Because of presence of rich amount of pectin, a high quality natural jelly is obtained from guava. Processed guava pulp is an excellent raw material for preparation of various other guava products such as nectars, beverages, jams, toffee, cheese, ice cream topping etc. Guava pulp can be preserved successfully in bulk either by application of heat (aseptic packaging) or addition of chemical preservation (SO_2). Canned guavas with sugar syrup (40° Brix), Dehydrated guavas, and guava powder are the other important products.

Pomegranate (*Punica granatum*)

Since, pomegranate is highly popular as a fresh fruit, it is not used for processing to a great extent. Pomegranate juice is highly acceptable drink. The steps in making of juice drink include, extraction of juice, clarification in a flash

pasteurizer, cooling, settling for 24 hours, racking up, filtering and heat preservation. Anardana is made from pomegranate seeds, particularly of the sour type, after drying they are used as acidulant for culinary purpose.

Custard apple (*Annona squamosa*)

Custard apple is not used for processing purpose to a great extent. On heating the pulp it develops bitterness. So pulp can be frozen successfully for use in the icecream industry. Ready to serve beverages are made from custard apple. Bitterness of the pulp can be removed by treating with peptic enzyme.

Jackfruit (*Artocarpus heterophyllus*)

The fruit is used both in the unripe and ripe stage. Raw jackfruit is popularly used as a vegetable. Fully mature but unripe fruits are harvested and appearance and a dull sound upon tapping judge fruit maturity. Ripe jackfruit is consumed as a dessert fruit. Jackfruit chips are prepared by frying ripe or semi-ripe fruits. Jackfruit leather is also prepared from the ripe or semi-ripe fruit. A palatable beverage concentrate can be made from jackfruit pulp by adding sugar, citric acid and water. In addition high class canned, frozen and dried products such as nectar, preserves confections etc can be prepared from the ripe fruits. The green jackfruit utilized for making pickle, canned and curried vegetables. The wastes (skins, peels and cores), which constitute about 45% of the total fruit weight, have been found to be a fairly good source of pectin.

Bael fruit (*Aegle marmelos*)

The bael fruit is known for its medicinal properties. The bael fruit is one of the most nutritious fruits. It contains 61.5 g of water, 1.8 g of protein,1.7g of minerals,31.8g of carbohydrates and1.19mg of riboflavin/100 g edible portion. It may be noted that no other fruits has such a high content of riboflavin. Bael fruit has been used from time immemorial for processing in the mature green form to prepare preserves. The difficulty in the extraction of ripe bael fruit pulp is overcome by addition of water equal in weight to the pulp, adjusting the pH to 4.3 with citric acid and heating at 80C for one minute, before passing through the extractor/pulper. Addition of water dilutes the mucilage and the application of heat not only inactivates the enzymes but also helps in dissolving the mucilage uniformly throughout the pulp. The fruit pulp thus obtained has almost

the same consistency and colour as mango pulp. Ripe Bael fruit pulp, if extracted properly can be used for the preparation of various fruit products viz., nectar squash/leather/slab, powder etc., which can be commercially exploited.

Aonla (*Phyllanthus emblica*)

The fruit is highly nutritious and is a rich source of pectin and polyphenols apart from ascorbic acid. Aonla fruits are well known for their medicinal properties. The fruits are used for curing chronic dysentery, bronchitis, and diabetes. The storage of Aonla depends on maturity at harvest. The fruit keeps well in cool chamber for 17-18 days compared to 8-9 days at ambient temperature.

Aonla fruit is seldom consumed fresh but the fruit is valued highly in the Ayurvedic system of medicine. In Ayurvedic preparation like 'Chyavanprash' and triphala, Aonla is one of the main ingredients. Fruit products like pickle, preserve, candy, jam, syrup and dried shreds are made from Aonla. Aonla preserve is very important article of commerce and is in great demand. Steaming or blanching the fruit prior to processing can minimize ascorbic acid loss in the products.

Jamun (*Syzygium cumini*)

It is reported that jamun fruits are used for making products such as jam, jelly beverages, wine and vinegar. It has been found that maximum yield of jamun juice with a high level of anthocyanins and other soluble constituents can be obtained by grating the fruit, heating to 70°C, and passing through basket press. The jamun juice thus obtained is again heated to 85°C and then cooled to room temperature. Sodium benzoate (500pm) is added to the juice before it is stored. Pure jamun juice can also be stored by heat pasteurization. The juice being highly acidic is not consumed as such. A ready to serve beverage (nectar) is prepared with 25%juice, 18° Brix and 0.6% acidity. Jamun seeds are also known for their properties which help to cure diabetes, diarrhea and dysentery.

Steeping preservation of vegetables with hurdle technology

The retention of sensory and nutritional quality in vegetables is the biggest challenge to the processors for the benefit of consumers. It all depends on the application of safer food additives in judicious manner.

The combined safer additives acts as hurdles to inhibit the growth of microorganisms and prevent the biochemical reactions leading to breakdown of vegetable constituents such as carbohydrates, proteins and vitamins. The most important hurdles used in vegetable preservation are temperature, water activity, acidity, redox potential, preservatives and competitive microorganisms.

The hurdles in vegetables can be kept at optimal range, considering the safety and quality and thus affecting the total quality of foods. A certain set of hurdles is inherent for each stable and safe vegetable which differs in quality and intensity depending on the particular product. But in any case, the hurdles must keep the normal population of microorganisms in the vegetable under control.

The microorganisms present in vegetable should not be able to overcome the hurdles present during storage of the product otherwise the vegetable will spoil or even cause food poisoning. Basic preservation methods imply putting microorganisms in a hostile environment, in order to inhibit their growth or shorten their survival or cause their death. The feasible responses of microorganisms to this hostile environment determine whether they may grow or die.

Recent advances have been made by considering the homeostasis, metabolic exhaustion and stress reactions of microorganisms in relation to hurdle technology, as well as by introducing the novel concept of multi target preservation for a gentle but most effective preservation of hurdle technology foods.

Multi target preservation refers to ambitious goal for a gentle and most effective preservation of foods. It has been reported that different hurdles in a food might not have an additive effect on microbial stability, but they could act synergistically. A synergistic effect could be achieved if the hurdles in a food hit at the same time different targets such as cell

membrane, DNA, enzyme systems, pH etc. within the microbial cells and thus disturb the homeostasis of the microorganisms present in several respects. The repair of homeostasis as well as the activation of stress shock proteins becomes more difficult.

It is anticipated that the targets in microorganisms of different preservative factors for foods should be elucidated and the hurdles may be grouped in classes according to their targets. A mild and effective preservation of foods is effective if the preservation methods are based on intelligent selection and combination of hurdles taken from different target classes. The synergistic approach is probably not only valid for traditional food preservation procedures but as well for modern processes such as food irradiation, ultra high pressure, pulsed technologies.

Multi target effect is effective in controlling the highly contagious diseases such as tuberculosis and AIDS. The use of antimicrobials is a common practice for preservation of foods. The incorporation of antimicrobial in a food recipe reflects towards inhibition of spoilage and pathogenic microorganisms which results in the compositional modification of food. The majority of consumers are demanding the natural antimicrobials such as bacteriocins which inhibit the microbial growth.

Bacteriocins are proteinaceous compounds consisting of peptides and amino acids with antimicrobial activity and are synthesized by the ribosomes of the microbial cells. Over the decades, numerous bacteriocins produced by lactic acid bacteria (Lactobacillus, Lactococcus, Enterococcus, Pediococcusand Carnobacterium) have been isolated and characterized as nisin, lactococcins, sakacins, curvaticins, carnobacteriocins, pediocins, etc. Bacteriocins gained increased attention because of their potential application as natural antimicrobials in foods to substitute or decrease the addition of other chemical preservatives which are considered hazardous.

Flow diagram for steeping preservation of cauliflower

Cauliflower
↓
Sorting, washing and cutting of stalk
↓
Cauliflower pieces (3-4 cm)
↓
Blanching in boiling water for 30 sec in muslin cloth
↓
Steeping into 3.5% sodium chloride solution, 1.1% acetic acid, 350 ppm sulphur dioxide
↓
Storage of cauliflower in glass bottles with steeping solution for 8-10 months at 25-30°C

Usage: Steeped cauliflower is washed in water and it is used for pickle or curry preparation.

Flow diagram for steeping preservation of french bean

French bean
↓
Removal of stalk and washing
↓
Cutting into 4-4.5 cm long length pieces
↓
Blanching of french bean pieces in boiling water containing 0.1% magenisium oxide followed by steeping into 1% sodium sulphite solution for 10 min
↓
Steeping in 2.0 - 2.5% sodium chloride solution, 0.25-0.3% acetic acid, 350 ppm benzoic acid and 350 ppm sulphur dioxide
↓
Storage of french bean in glass bottles with steeping solution for 2-3 months at 25-30°C

Usage: Steeped french bean is washed in water and it is used for pickle or curry preparation.

Drying technology in Vegetables

Drying or dehydration is one of the most effective means to extend the shelf life of perishable fruits and vegetables. The main purpose of dehydration in preserving fruits and vegetables is to remove moisture so that water activity of the dehydrated products is low enough of water activity less than 0.6 for preventing the spoilage and the growth of pathogenic microorganisms and subsequently to reduce the spoilage reactions.

Dehydration is also used in combination with other preservative factors such as initial heating of vegetable in boiling water and salt solution to extend the shelf life of vegetables. Dehydration significantly reduces the cost of transportation and storage due reduced weight and volume of dehydrated vegetables. Unlike fresh vegetables, dehydrated vegetables do not require refrigeration during storage.

Sun drying has been used since ancient times to produce dehydrated vegetables. This method is expensive but the effectiveness of drying depends on bright sunshine and longer drying times. The dried vegetables with sun drying are not widely acceptable due to unhygienic quality. Another dehydration technique, viz., osmo-air drying is a simple process and has potential advantages for preservation of vegetables for longer duration. The inclusion of osmotic process in conventional dehydration has major objectives of quality improvement and energy savings.

This process also resulted in quality improvement in terms of colour, flavour, texture, product stability, nutrient retention and prevention of microbial spoilage during storage. Different factors such as pretreatment, nature and concentration of osmotic solution, raw material characteristics, stage of maturity, size of slices, duration of osmosis, ratio of slice to brine concentration and agitation influence the quality of dried vegetables. Osmo air-drying has greater potential for drying of large quantities of vegetables with good sensory properties. This drying can be adopted as a rural based simple technology by small entrepreneurs, home-scale industry and also by self-help group in close association with NGOs. Small entrepreneurs can adopt this process on large scale.

The principle involved during dehydration involves removal of moisture by application of heat under controlled conditions of temperature, humidity and air flow. In this process, single layer of sliced and shredded vegetables after blanching treatment is spread on trays in the dryer. The initial dryer temperature in cabinet or tray dryer is normally adjusted to 60-65°C for 4-5 hrs and afterwards the dryer temperature is reduced to 50-55°C for completion of drying with final moisture content to less than 2%.

However, various factors such as composition of vegetables, size, shape and arrangements of vegetables in the tray, temperature and movement of hot air across the trays, heat transfer from vegetable surface such as conductive and convective rate of heat transfer. Newer innovative drying processes have significantly improved the sensory qualities and retention of nutrients in dried vegetables. The use of additives improves in retaining green colour, ascorbic acid and bioactive compounds in dried vegetables. Drying process also improves the rehydration quality and thus improves the aesthetic quality in dried vegetables.

Vegetables during drying process behaves constant and falling drying rate of moisture removal from vegetables. Constant drying rate refers to removal of moisture in proportion to the application of heat. Higher heating temperature initially removes the moisture from faster rate during constant drying rate. However, during the course of drying, the moisture content is reduced to much lower level as a result moisture removal is not proportional to the application of heat to vegetable surface.

The reduced level moisture removal refers to falling drying rate in vegetables. This drying can be adopted as a rural based simple technology by small entrepreneurs, home scale industry and also by self-help group in close association with NGOs. Small entrepreneurs can adopt this process on large scale. There is ample scope for cost reduction through the use of solar energy for brine concentration and dehydration process.

Flow diagram of osmo-air drying of carrot slices

Carrot
↓
Grading, washing and cutting into slices (0.2-0.25 cm)
↓
Blanching in 20% sugar solution at 80-85°C for 4-5 min followed by dipping into 0.2% potassium metabisulphite solution for 10 min
↓
Osmotic diffusion of 50-55% sugar solution at 50-55°C for 90 min
↓
Cabinet drying of carrot slices
I stage of drying at 60°C for 3-4 hrs
↓
II stage of drying at 50-55°C for 8-10 hrs
↓
Cooling at room temperature
↓
Storage in air tight plastic containers at 10-15°C for 4-6 months

Usage: Osmo-air dried carrot slices is directly consumed as sweet meat.

Flow diagram of drying of okra

Okra
↓
Sorting, Grading and Washing
↓
Blanching in boiling water containing 0.1% magnesium oxide for 1 min followed by dipping into 1% sodium sulphite solution for 10 min
↓
Cutting into 0.25-0.3 cm slices
↓
Drying in cabinet dryer at 55-60°C for 6-8 hr
↓
Cooling at room temperature
↓
Packaging in polypropylene pouches and storage at ambient temperature (20-25°C) for 6-8 months

Usage: Dried okra is fried in refined oil along with spices followed by addition of water for rehydration during curry preparation.

Pickling and Fermentation of Vegetables

The preservation of food in common salt or in vinegar is known as pickling. It is one of the most ancient methods of preserving fruits and vegetables. Pickles are good appetizer and add to the palatability of meal. Pickles help in stimulation of gastric juice and thus help in digestion. Several kinds of pickles are sold in the Indian market.

Mango pickles rank first followed by cauliflower, onion, turnip and lime pickles. Pickles are either manufactured at cottage or home scale as well as commercially manufactured and exported.

Pickling is the result of fermentation by lactic acid bacteria which are generally present in large numbers on the surface of fresh vegetables and fruits. These bacteria can grow in acid medium and in the presence of 8-10% salt solution, whereas the growth of majority of undesirable organisms is inhibited. Lactic acid bacteria are most active at 30°C, so this temperature must be maintained as far as possible in the early stage of pickle manufacturing process. When vegetables are placed in brine, it penetrates into the tissues of vegetables and soluble material present in vegetable tissues diffuses into brine solution by osmosis.

The soluble material basically includes fermentable sugars and minerals. The fermentable sugar is broken down by lactic acid bacteria which convert them into lactic and other acids. The acid brine thus formed acts upon vegetable tissues to produce characteristics taste and aroma of pickle. In the dry salting method, several alternate layers of vegetables and salt are kept in vessel which is covered with a cloth and a wooden board is allowed to stand for about 24 hrs. During this period, sufficient juice comes out from vegetables to form brine. The growth of majority of spoilage organisms is inhibited by brine containing 15% salt. Lactic acid bacteria which are salt tolerant, can thrive well in brine containing 8-10% salt. It is therefore, advisable to place the vegetables in 10% salt solution for vigorous lactic acid fermentation.

In dry salting method of fermentation, fermentation process starts and carbon dioxide begins to evolve. The salt content is gradually increased to 15% for steady fermentation process. Under favourable conditions, fermentation is completed in 7 to 10 days.

NOVEL TECHNOLOGIES IN PROCESSING AND STORAGE

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Introduction

The growth in the food processing sector in India is driven mainly by the increased demand for processed food products.The consumer is shifting towards more value-added food categories like ready-to-eat food products. In addition, there is a growing demand for processing basic products such as fruits, vegetables and grains which require technologically advanced equipment. Therefore, there is a need to adopt new methods, technology, and machinery for the food processing industry. Technological advancements are necessary for the growth of the sector and for the diversification of the existing production capacity of the food processing industry. Some of the advanced techniques that can be adopted in micro food processing enterprises are given below.

Technology of Vacuum Frying

Frying in vacuum condition is a new technology that can be used to improve the quality of fried foods because it is working in low temperatures and use the minimum oxygen content. Deep-fat frying is a method to produce dried food where an edible fat heated above the boiling of water serves as the heat transfer medium, fat also migrates into the food, providing nutrients and flavor. These conditions lead to high heat transfer rates, rapid cooking, browning, texture, and flavour development. Therefore, deep-fat frying is often selected as a method for creating unique flavors, colors, and textures in processed fried foods. However, surface darkening and many adverse reactions take place during deep-fat frying because of high temperature. Due to the pressure lowering, the boiling points both of the fat and moisture in the foods are lowered. Vacuum frying is an alternative technique to improve the quality of dehydrated food.

Fig.1. Vacuum Frying Machine

Fig. 2. Vacuum fried jackfruit chips

Vacuum fried products have low moisture content (<6%) and low water activity(a_W< 0.3). The absence of air during frying may inhibit oxidation including lipid oxidation, enzymatic browning; therefore, the color and nutrients of fried samples can be largely preserved. The products are crispy and retain original colour, taste and odour as of the natural foods.

In future, the vacuum fried products would be a suitable alternate for conventional fried products with better nutritional and sensorial properties. It would be more preferred over the fried products due to low oil and acrylamide content. With time, consumers are becoming more and more health and diet conscious and this tread promises a bright future of vacuum processing as a novel method of food processing.

Vacuum frying has some advantages, first it can reduce oil content in the fried product. Second, it can preserve natural color and flavors of the product depend to the low temperature and oxygen content during frying process and third it has less adverse effect on oil quality.Vacuum fried products are less objectionable and more convenient to carry when compared with fresh ones.

Vacuum frying can be used to fry high sugar fruits and fresh vegetable and tubers in order to produce various kinds of snacks. Sugar is burnt before water is removed from the fruits. The products still have high moisture content. The low pressure may allow air to diffuse faster into the porous structure, obstructing oil passage and leading to lower oil absorption than is observed in atmospheric frying. Sudden increase in the surrounding pressure, which may force the vapours & oil inside of the pores. Vacuum fried carrot slices absorb 47 % and less oil than atmospheric fried ones between 60˚C and 80˚C.

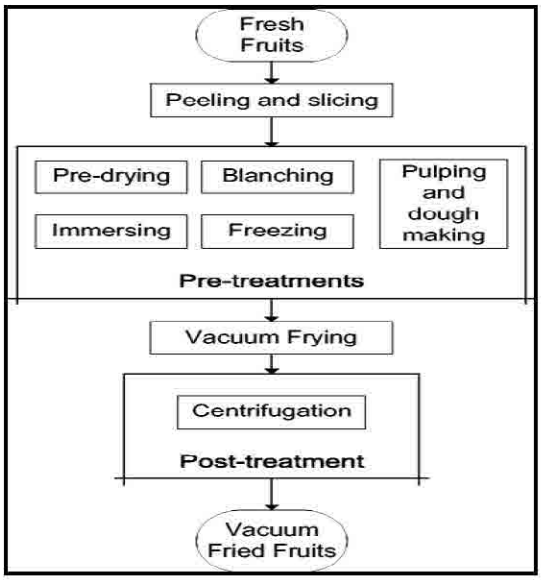

Fig. 3. Process flow diagram for vacuum frying of fruits

In plantain chips (5 minutes) and jackfruit chips (25 minutes) vacuum frying is a promising technique that can be used to reduce oil content. In addition, colour parameters like Lightness, redness and yellowness are best preserved in vacuum frying.

Minimal processing of fruits and vegetables

Minimally processed operations have been defined as, those procedures such as washing, sorting, trimming, peeling, slicing, chopping, anti-oxidants treatments and packing etc. that do not affect the fresh like quality of fruits & vegetables. The minimally processed fruits & vegetables are the products that are partially prepared so that no additional preparation is required for their use. The result of such operation is that the products can be prepared and consumed straightway in very short time.

A characteristic aspect of minimal processing is an integrated approach, where raw materials, handling, processing, packaging and distribution must all be properly considered to make shelf-life extension possible. New cultivars need to be selected and created or hybrids adapted to meet the specific requirements of minimal processing.

The equipment used in unit operations, such as peeling and shredding, needs further development so that it can process produce more gently. There is no sense in disturbing the quality of produce by rough treatment during processing, and patching it up after-wards by the use of preservatives.

The commonly terms referred to minimally processed products are Lightly Processed, partially processed, Ready to Eat or Ready to Cook. Minimally processed fruits and vegetables offer a number of advantages such as, convenient time saving and reducing solid waste problems. The physiology of MP products is essentially the physiology of wounded tissue.

Fig. 12. Minimal Processing Unit

Fig.13.Minimally processed vegetables

There is an increase in rate of respiration and ethylene production, oxidative browning, water loss and texture loss. The spoilage organism including different species of bacteria and microbial growth on MP products can be controlled by good sanitation; achievement the HACCP (Hazard Analysis Critical Control Point) proper temperature management during and after sharp stainless-steel knives or blades, use of proper packing material, the low O_2 and elevated CO_2 levels sometimes in conjunction with carbon monoxide or nitrogen retards the microbial growth.

The use of low temperature storage (0-50 ˚C), chemical preservatives such as chlorine (140 ppm), ascorbic acid at 3-5 % and sodium meta bisulphate at 200 ppm, reduction of water activity by centrifugation and modified and controlled atmosphere helps in retaining the quality and extend the storage life by inhibiting metabolic activity, decay and ethylene production.

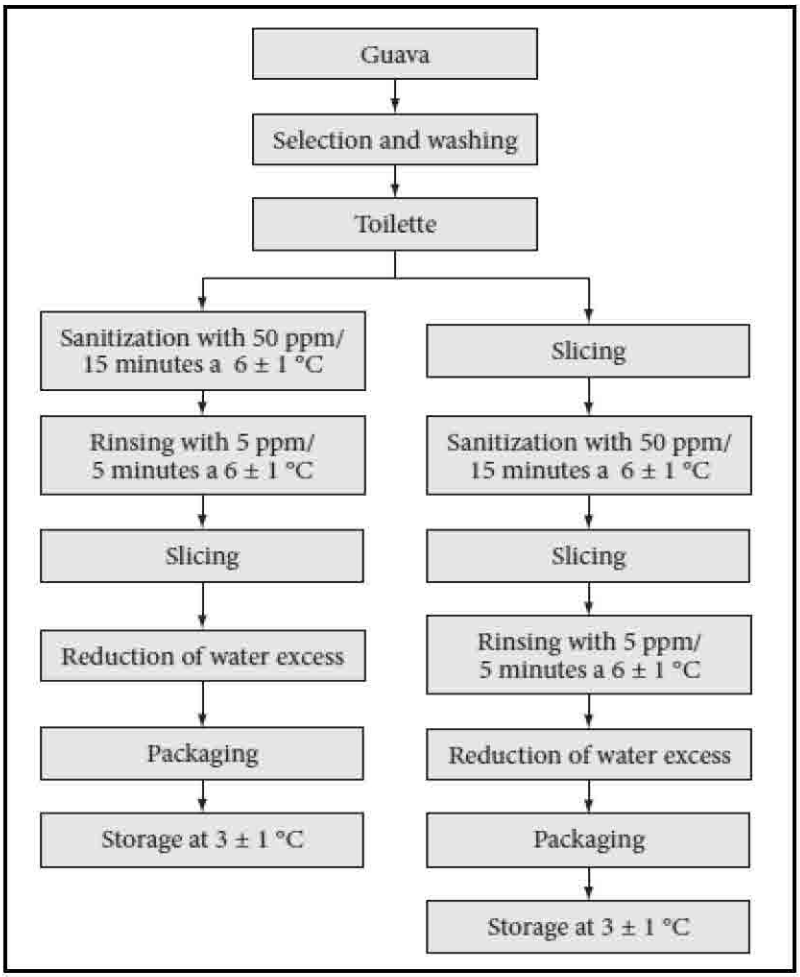

Fig.14. Process flowchart for minimal processing of guava

The polyvinyl chloride (PVC) primarily used for over wrapping and polypropylene (PP) and polyethylene (PE) bags are used for packing of MP products. Edible coatings offer a possible method of extending storage life of MP products.

Spray drying of fruit and vegetable powders

It is a unit operation by which a liquid product is atomized in a hot gas to obtain a powder. The gas generally used is air or more rarely an inert gas as nitrogen. The initial liquid feeding the spray dryer can be a solution, an emulsion or a suspension. spray drying is used in dehydration process and is used in the preparation of dried materials such as powdered milk and also used in encapsulation process.

To prepare materials for spray drying, the carrier or wall material (such as malt dextrin, modified starch, gum or combination of these) is hydrated. The flavour

or ingredient to be encapsulated is added to the carrier and homogenized or thoroughly mixed into the system. A typical ratio of carrier to core material is 4:1, however, in some applications higher flavour loads can be used. The mixture is homogenized to create small droplets of flavour or ingredient within the carrier solution. The creation of a finer emulsion increases the retention of flavour during the drying process.

The core/wall material mixture is fed into a spray dryer where it is atomized through a nozzle or spinning wheel. Hot air flowing in either a co-current or counter-current direction contacts the atomized particles and evaporates the water, producing a dried particle that is a starch or carrier matrix containing small droplets of flavour or core. The dried particles fall to the bottom of the dryer and are collected. A thorough understanding of the core material and intended application is important to select the appropriate wall material and to optimize drying.

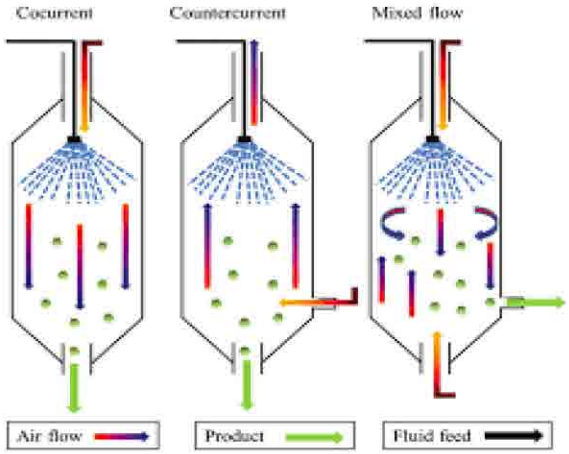

Fig.15. Spray dryer Unit Fig.16. Different types of spray dryer

The design of a spray drying process includes establishment of the operating conditions that increase product recovery and produce an end product of a precise quality specification. Product recovery is mainly determined by powder collection efficiency. Material loss in a spray drying system is due mostly to the attachment of sprayed droplets and dry powder to the wall of the dryer. Particle adhesion to the wall is affected by the nature of the spray-dried material and spray drying conditions, and is a commonly recognized effect in spray drying solutions containing sugars, such as fruit juices and tomato product. During the drying process they may either remain as syrup or stick on the dryer chamber wall.

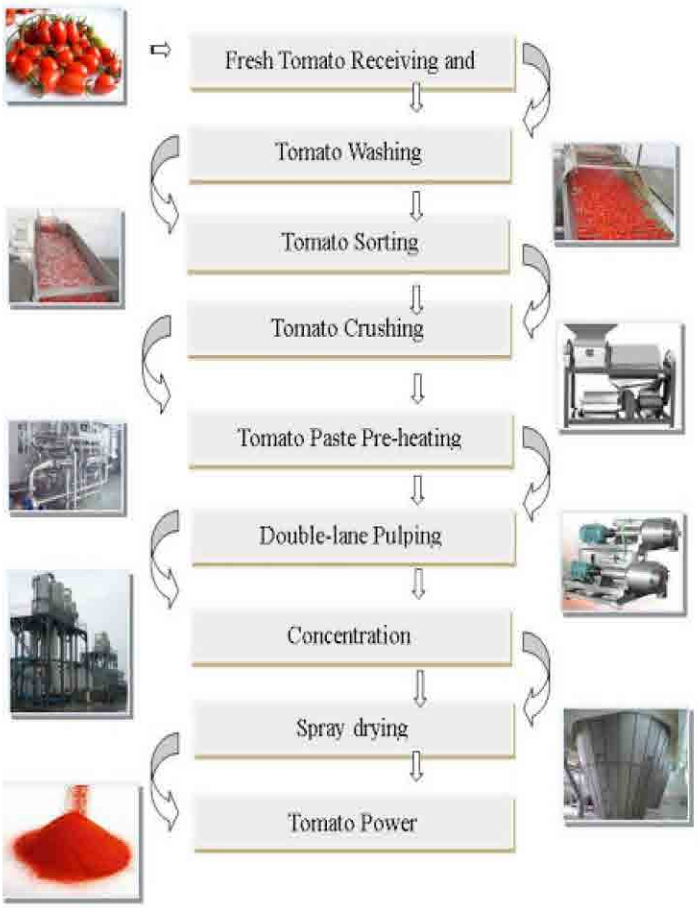

Fig.17. Process flowchart for processing of tomato (spray drying)

The advantages of spray drying include low processing costs and readily available equipment. It generally provides good protection to the core material and there is a wide variety of wall materials available. One main disadvantage is that it produces a very fine powder which needs further processing such as agglomeration to instantize the dried material or make it more readily soluble if it is for a liquid application.

Storage techniques of fruits and vegetables

Cold storage of fruits and vegetables

Cold storage is the one widely practiced method for bulk handling of perishables between production and marketing. It is one of the methods of preserving perishable commodities in fresh and whole some state for a longer period by controlling temperature and humidity within the storage system. Maintaining adequate low temperature is critical. As otherwise it will cause chilling injury. Also, relative humidity of the room should be kept as high as possible (80-90%) for most of

the produce, either below or above percentage leads to detrimental effect on the keeping quality. Before storing the produce, precooling is the necessary procedure to remove filed heat, allowing for long storage period.

Fig.18. cold storage of fruits and vegetables

Advantages of Low temperature (Cold storage) are: Cold storage of fruit and vegetables leads to better maintenance of organoleptic qualities, reduced spoilage and longer shelf-life.

- ✓ Reduce respiration and internal breakdown by enzymes
- ✓ Reduce water loss and wilting
- ✓ Slow down the growth of disease organisms
- ✓ Reduce the production of ethylene
- ✓ Provide “time” for proper handling, packaging and marketing

All fruits and vegetables have a specific temperature and relative humidity requirement for storage. A success of cold storage mainly depends on temperature, relative humidity and air movement. Cold and cool conditions result in a substantial decrease in loss due to spoilage. Availability of proper cold storage is important for preserving perishable commodities like milk, meat, eggs, vegetables, fruits, ornamental flowers, and other floricultural goods. Each fruit or vegetable has its own ideal set of conditions at which it will store most successfully for the maximum length of time. The four classifications based on conditions are:

1. Vegetables which require cold & moist conditions
2. Vegetables which require cool & moist conditions
3. Vegetables which require cold & dry conditions
4. Vegetables which require warm & dry conditions.

Controlled and Modified Atmosphere Storages of Fruit and Vegetable

Controlled atmosphere storage (CA) and modified atmosphere storage (MA) techniques used in the long-term storage of fruit and vegetables using low oxygen atmospheres. A reduction in the concentration of oxygen and/or an increase in carbon dioxide concentration of the storage atmosphere surrounding a produce reduces the rate of respiration of fresh fruits and vegetables and also inhibits microbial and insect growth.MA and CA usually involve atmospheres with reduced O_2 and elevated CO_2 levels. Modified atmosphere (MA) refers to any atmosphere different from the normal air while controlled-atmosphere storage (CAS) refers to change in normal gas composition and strictly monitored and constantly controlled.

Control atmosphere (CA): generally, refers to decreased O_2 and increased CO_s concentrations, by a precise control of the gas composition. - Gas atmosphere is continuously controlled throughout the storage period. Scrubbers are used in controlled atmosphere storage to absorb the extra amount gases present inside the packaging material. For vegetables, such as potatoes, carrots, garlic, and horseradish, which can be successfully stored in air, controlled atmosphere storage. The highest level of appreciation of CA in vegetables is with broccoli, cabbage, lettuce, asparagus, and Brussels sprouts.

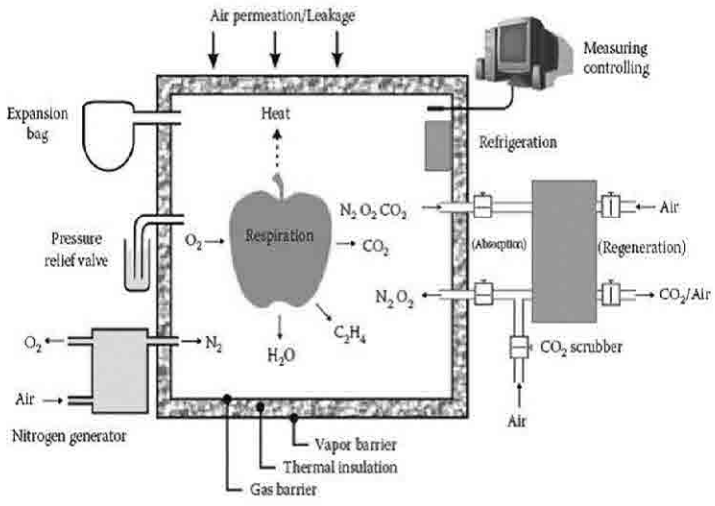

Fig.19. Schematic representation of CA storage

Modified Atmosphere (MA): is used when the control of the storage atmosphere is not closely controlled, such as in plastic film packaging. Gas composition is modified initially and it changes dynamically depending on the

respiration rate of produce and permeability of film or storage structure surrounding the produce. The main aim of modified atmosphere packaging (MAP) is to change the composition of the atmosphere around the product so that the storage life of the product can be extended. Most fruit and vegetables age less quickly when the level of oxygen in the atmosphere surrounding them is reduced. This is because the reduced oxygen slows down the respiration and metabolic rate of the products and therefore slows down the natural aging process. The difficulty with using modified atmosphere packaging is the establishment of a stable atmosphere inside the plastic bag

Fig.20. Modified storage of fruits and vegetables slice

Benefits of CA and MA Storage

- Retardation of senescence and associated biochemical and physiological changes
- Reduction of fruit sensitivity to ethylene
- Controlling certain physiological disorders
- Controlling postharvest diseases and decaying by inhibiting pathogens and insects
- Delayed softening and mealiness (apples, pears, tomatoes)
- Delayed toughening (asparagus)
- Chlorophyll retention (apples, pears, leaf vegetables)
- Insect control- O_2(< 1%) and/or elevated CO_2(40 to 60%)
- Inhibition of the browning of cut surface (cut fruits and vegetables)
- Better flavour retention (pineapple, cabbage)
- Higher nutritional value after storage (vitamin C).

VALUE ADDITION OF PLANTATION CROPS

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Introduction

Plantation crops are high value industrial crops grown in the tropics having great economic importance. They have great potential for utilization of waste land like rainfed dry land, hilly, arid and coastal areas to provide nutritional security, earn foreign exchange and to ensure livelihood security. The major plantation crops grown in India are tea (Camellia sinensis L), coffee (Coffea arabica L.), rubber (Hevea brasiliensis), coconut (Cocos nucifera), arecanut (Areca catechu L.), oilpalm (Elaeis guinensis), cashewnut (Anacardium occidentale L.) and cocoa (Theobroma cacao L.).

India is the leading producer of most of these plantation crops. Among all fruit crops, the processing plays an important role in plantation crops as they are generally consumed only after processing. Coconut, arecanut, cashewnut, black pepper and cardamom are known as small holder plantations whereas, crops like rubber, tea and coffee are known as estate crops or conventional plantation crop.

A. TEA (Camellia sinensis L)

Tea is an evergreen woody perennial grown in many Asian countries including China, Japan, Java, Sumatra and India. Tea belongs to family Camelliaceae. The plant produces dark green, small shiny leaves with white blossom. In post harvest and manufacturing practices for tea, only mechanical and physical processes are followed with natural fermentation. It can be manufactured by orthodox, CTC (crush, tear and curl) processing.

Processing of tea

Tea processing is the method in which the leaves from the tea plant (Camellia sinensis L) are transformed into dried leaves for brewing. Processing steps broadly involves picking, withering, rolling, oxidation/fermentation, drying and curing/ageing. The steps involved are as follow:

1. Picking: Tea leaves and flushes, which include a terminal bud and two young leaves, are plucked from Camellia sinensis bushes twice a year during early spring and early summer or late spring. Generally hand picking is preferred for picking of tea leaves. Hand picking is done by pulling flush with a snap of wrist and does not involve twisting or pinching of flush, as twisting generally reduce the quality of leaves. Machine picking results in more broken leaves and is not suitable on mountain slopes where tea is grown.

2. Withering: Withering is used to remove excess water from the leaves and sometimes loose more than a quarter of their weight. Newly picked leaves are thinly spread in the sun or left in a cool breezy room to pull moisture out from the leaves. Heated air is sometimes forced over the leaves if the climate is not suitable. By the end of this process, the leaves become pliable enough for rolling. In order to quicken the oxidation process, the leaves may be bruised by tumbling in baskets or rolled-over by heavy wheels. The main purpose of this process is the partial expulsion of moisture and thus saving fuel consumed in drying operation and allows a very light oxidation.

3. Rolling: From the withering racks, the leaves are twisted and rolled to allow breaking of leaf cells. During rolling process, some of leaf juices and oils are released, that gives the tea its distinctive aroma and may aid in oxidation. The leaves can be rolled with rolling machine or by hand.

a) CTC processing: The CTC (crush, tear, curl) machine consists of two cylindrical rollers (61 or 91 cm long and 20 cm in diameter) having stainless steel segment having fine tooth like sharp ridges (3-4 ridges/cm in lengthwise and 50-60 ridges over circumference). The rollers are having marginal clearance and rotate in opposite direction at different speed in the ratio of 1:10 between slow: high speed rollers. The speed of 70:700 and 100:1000 rpm have good effects. The crush, tear and curl (CTC) maceration takes only few minutes.

b) Orthodox processing: The rolling is done normally in 36" or 46" diameter rollers. A tea roller consists of 3 main parts; a table fitted with cones and battens, a bottomless jacket and pressure cup fitted with adjusting screw to enable pressure to be applied to a desired extent. The roller may be table or jacket moving, normally rotates at 45 rpm speed. The battens are provided to form obstruction in the leaf

path. It increases frictional effect of roller table and breaks the leaf at the same time. Battens help in cutting the leaves in roller. The cone fitted at centre of table intensifies leaf circulation by causing a greater turning action provided by batten alone. With each turn of roller, the leaf caught between cone and roller jacket subjects to heavy pressure and this result in greater extraction of sap. The withered leaf is then charged into the jacket.

4. Oxidation/fermentation: Oxidation begins once the leaf membranes are broken down enzymatically during the rolling process. It is an important stage in black tea processing. During this stage, the most important properties of tea are produced. It is a chemical process where oxygen is absorbed and the leaves turn progressively darker. The tannins are released and transformed during this process. Oxidation causes the leaves to turn bright copper in colour. This process is the main deciding factor to prepare different types of teas like Green, Oolong or Black tea. For different types of teas, the extent of oxidation is 5-40% for light oolong tea, 60-70% for darker oolong tea and 100% for black tea. During fermentation, low temperature (20^0C) and high humidity (95%) are desirable.

5. Kill-green and shaping: After oxidation, kill-green is done to stop tea leaf oxidation at a desired level. Heating tea leaves moderately deactivate their oxidative enzymes without destroying tea flavour. The leaves after kill-green are allowed to be lightly heated in a closed container, which causes the previously green leaves to turn yellow. The damp tea leaves are then rolled to be formed into wrinkle strips.

6. Drying: The leaves are then dried evenly and thoroughly without burning. Drying of leaves stops the oxidation process. The main objective of drying is to arrest fermentation and to remove moisture and produce good quality tea. This can be done in different ways including conventional drying, fluidized bed drying and air drying or baking. Curing/ageing: Curing is not required for all types of teas however, some type of teas require additional aging or secondary fermentation to enrich their drinking potential. Flavoured teas are manufactured by spraying with aromas - and flavours or by storing them with their flavourants.

Different types of tea: On the basis of manufacturing method, commercial tea is broadly classified as black tea, green tea, oolong tea, yellow tea etc. The basic difference is in the degree of fermentation adopted during manufacturing of tea from the Camellia sinensis evergreen plant. Brief detail about type of teas is as under:

1. Black tea: Black tea is the most common form of tea in Southern Asia (Sri Lanka, India, Pakistan, Bangladesh etc.) and many African countries including Kenya, Rwanda, Malawi and Zimbabwe. The Black tea process goes through the most stages of processing like withering, leaf maceration, fermentation, drying and grading. After picking, the leaves are left to wither for several hours and allowed to oxidize completely. Rolling or maceration is done to bruise and disrupt the leaf cell structures to release the oil which aid in oxidation. The last step consists of placing the leaves in an oven with temperature reaching up to 93.3°C. When the leaves are 80% dry, the leaves complete their drying over wood fires. The final product is sorted accordingly to size, the larger size is considered "leaf grade," and smaller size "broken grade" which are usually used for tea bags. Black tea is further classified as either orthodox or crush, tear and curl (CTC) process tea.

2. Green tea: Green tea undergoes least amount of oxidation and the oxidation process is halted by quick application of heat, either with steam or by dry cooking in hot pans. Steaming of the leaves is done to prevent the leaves changing their colour from green to black and to inactivate the enzyme. It is followed by rolling. The leaves retain much of its original green colour especially the finer leaves whereas the older leaves have a blackish gray colour. For drying, the leaves are either stacked in hot air rack driers or are exposed to natural heat of sunlight. The tea is processed within one to two days of harvesting and retains most of the chemical composition of the fresh leaves in tea if processed properly.

3. Oolong tea: It is partially fermented tea. Oxidation is stopped somewhere between the standards for green and black tea. The fermentation period is short to change the colour of the leaf completely. The processing typically takes two to three days from withering to drying with a relatively short oxidation period. It is partially blackened. In oolong tea, the outer edge of the tea leaf is fermented while heart of leaf remains unfermented. The beverage is intermediate between those produced from green and black tea. The term "oolong" is used specifically as a name for certain semi-oxidized teas.

4. White tea: White tea is produced in lesser quantities than most other styles and is therefore, more expensive than tea from the same plant processed by other methods. It is mostly produced in China and is classified as organic or premium tea. It is produced from the young leaves or new growing buds that have undergone

minimal oxidation. The oxidation is halted after a slight amount of wilting with heat. Leaf buds processed into white tea are usually dried immediately after wilting/withering.

5. Yellow tea: Yellow tea is processed in a similar manner to green tea but instead of immediate drying, leaves are stacked, covered and gently heated in a humid environment. This initiates oxidation in the chlorophyll of the leaves through non-enzymatic and non-microbial means, which results in a yellowish or greenish-yellow colour. This tea is popular in Japanese tea ceremonies due to its appearance and distinctive flavour.

B. COFFEE

Coffee is an important beverage used all over the world. Brazil and Columbia are the largest coffee producers in the World. Coffea arabica accounts for 75-80% of World production. The domestic consumption of coffee in India stands at 85,000 tonnes valued at about Rs 2292 crores. Coffee is harvested during dry season when the coffee cherries are bright red, glossy and firm. Picking is done by hand or by using machine. After picking, the coffee can be prepared either by dry method which produces natural coffee or by wet method which produces washed coffee.

offee is harvested in one of two ways:

a) Strip picked: The entire crop is harvested at one time. This can either be done by machine or by hand. In either case, all of the berries are stripped off of the branch at one time.

b) Selectively picked: In this method, only the ripe berries are picked individually by hand. Pickers rotate among the trees every 8-10 days, choosing only the cherries which are at the peak of ripeness. This method being labour intensive and costly is used primarily to harvest the finer arabica beans.

Processing of coffee

Coffee processing is the most critical activity in its production. Processing of coffee deals with the conversion of raw coffee fruit into coffee. The quality of the final product depends upon the manner of processing. The methods employed for processing of coffee includes; dry method and wet method to produce unwashed and washed coffee respectively.

1. Dry method: The harvested cherries are spread over a concrete, brick or matting surface in suitably at good raked at regular intervals to prevent fermentation. In about 7-10 days the cherries dry to about 11% moisture. The outer shells become dark brown and brittle. The dried cherries are then stored in silos, where beans continue to loose moisture.

2. Wet method: In wet method, the beans are separated from the skin and pulp using a pulping machine. The beans are stored in a fermentation tank for 12-48 hours, during which time enzymes work to naturally separate the slimy layer (parenchyma) from the parchment like covering (endocarp). When the process is complete, the endocarp has pebbly feel. Coffee processed by the wet method is called wet processed or washed coffee and is found superior in quality as compared to dry processed coffee.

Drying: The endocarp is dried in open sun or in mechanical drier to moisture content of about 11% so that beans can be stored in stable condition. In open sun drying, it takes 7-15 days for drying. The coffee is called as parchment coffee.

Hulling: In wet processed coffee, hulling is used to remove the hull or dried parchment layer surrounding the beans. In dry processed coffee, hulling refers to removal of husk or whole of dried outer covering of original cherries.

3. Roasting: Raw green coffee does not have any flavour or aroma and has an unpleasant taste. Roasting is a heat treatment which transforms the green beans into aromatic brown nuggets. Roasting is done at air temperature of 287.8^{o}C and in this process the beans are kept moving to avoid burning. When the bean temperature reaches 209^{o}C they start turning dark brown and oil (called coffee oil or caffeol or coffee essence) start to emerge. This process is called Pyrolysis is the heart of roasting, as it produces aroma and flavour of coffee. After roasting, beans are cooled by air or water. The cooling must be quick in order to preserve the flavour, aroma and keeping quality.

4. Grinding: The bulk of roasted beans is ground to powder and sold as ground coffee. Roasted beans are ground to three sizes namely fine, medium and coarse. Coarse ground powder retains aroma and flavour better and longer than fine ground powder. Coarse ground powder is more suitable for preparing coffee decoction by percolation. On the other hand, fine ground coffee gives a decoction with high body.

5. Blending: Two types of coffee powder are marketed namely pure coffee prepared from coffee seeds only and French coffee. Chicory strength, flavour, aroma and acidity are the chief criteria in judging the quality of coffee.

6. Packaging: For larger packs of roasted and ground coffee, gas packing under carbon dioxide or under vacuum is effective. Various flexible films like polyethylene (PE), cellulose films etc are used for packing coffee.

Different types of Coffee

1. Decaffeinated Coffee: The coffee from which caffeine is artificially removed is known as decaffeinated coffee. There is a prominent segment of consumer preferring decaffeinated coffee owing to health consciousness.

2. Estate Coffee: Production of good quality coffee by highlighting special features of estate can be classified as estate branded coffee. The estate coffee are generally more expensive and actually define the specialty coffee market.

3. Monsooned Coffee: These are prepared by the special natural process which possesses a special monsooned flavour, mellow taste and golden look. It is also produced in India. It is graded as Monsooned Malabar AA, Monsooned Basanally and Monsooned Robusta AA.

4. High Grown Coffee: The coffee grown at higher elevations more then 1250 m above mean sea level possessing distinct flavour and acidity in cup (tasting) due to slower development of beans is called high grown coffee. The coffee is of high quality with dense beans.

5. Mysore Nuggets Extra Bold: The beans are large, uniform blush green in colour with a clean polished appearance. In cup, coffee exhibits full aroma, medium to good body, good acidity and fine flavour with a tint of spice. Arabica plantation coffee (worked coffee) is grown in the Mysore, Coorag and Billigiris regions. It is a premium coffee that represents the best quality coffee in India.

6. Robusta Kaapi Royale: it is made from Robusta Parchment AB from the regions of Mysore, Coorag, Wynad, Shivaroys, Pulneys and Barbabudans. The beans are bold, round with pointed ends and gray to bluish gray in colour. This cup ensures full body, soft, smooth and mellow flavour.

C. COCOA

Cocoa (Theobroma cacao L. family Sterculiaceae) beans are the primary raw material for confectioneries, beverages, chocolates and other edible products. Cocoa powder, butter and chocolate are the major products.The harvesting of cocoa pods is done at 7-10 days interval and the harvested pods may be kept for 2-4 days before they are opened for fermentation. Hitting pods against hard surface may be adopted for opening of pods. The main characteristics of cocoa beans are initial moisture contents (52-55%), final moisture content (6-8%), fat contents (55-58%) and acidity of 5.8 percent. The pod husk contains 6-8% crude protein and 24-56% crude fibre.

Processing of cocoa: Curing is the process by which cocoa beans are prepared for the market. Curing involves two unit operations; fermentation followed by drying. Fermentation involves keeping cocoa beans well insulated so that heat is retained whole, at the same time air is allowed to pass through the mass. The process lasts up to 7 days and immediately followed by drying. The flavour of cocoa is developed only when it undergoes fermentation.

1. Fermentation: Fermentation of cocoa beans is essential to remove mucilaginous pulp, to develop flavour and aroma precursors, reduce bitterness, kill germ of seed and to loosen the testa. The cocoa pods after harvesting are cautiously opened. The beans and the mucilage are scooped out and subjected to natural fermentation. They are piled in heaps in perforated wooden bins for a period of 3-12 days. The heat produced during fermentation raise the temperature to about 45-60°C. The fermentation is complete when temperature of mass begins to fall. At the end of fermentation, the pulp breaks down and the seed colour change from pale yellow to violet to brown. For fermentation the heap, box, tray and basket methods can be followed.

2. Drying: The fermented beans contain 33% moisture. They are dried to reduce moisture to 6-8% in sun or hot air dryers. During this process, the colour of the shell changes to dark brown. The dried beans are packed in polyethylene lined gunny bags and stored in a cool and dry place. The dried beans can be used for manufacture of different products.

Chocolate from cocoa beans

Important steps used for making chocolate from dry cocoa beans include roasting, grinding, refining, conching and tempering.

1. Roasting: The dried beans are cleaned, sorted and roasted at 150-160°C for 40-50 minutes. Roasting develops characteristic flavour and colour. It also causes changes in chemical structure of polyphenols producing less astringency compound.

2. Shelling: Shelling is done to remove the shells from the beans and grains become regular in size. Shelling is carried and by milling, sifting and winnowing. Shelled beans can be made into fine, smooth chocolate.

3. Milling: The roasted, shells and crushed beans are milled to reduce them to even finer particles.

4. Refining: Refining converts the milled particles into liquid cocoa mass created as cocoa butter in the beans binds dry particles.

5. Conching: Conching involves powerful machines called conches to stir the chocolate in a controlled way. It is done in two steps.

- **Dry conching:** The chocolate is slowly stirred at above 80°C temperature to remove any residual moisture and improve viscosity.
- **Liquid conching:** It is followed immediately after dry conching in the same conch without stopping the machine to affect the texture and creaminess. Little quantity of cocoa butter is also added in the process.

6. Tempering: it is done to transform liquid or semisolid chocolate into a solid. Chocolate is heated to melt the cocoa butter crystals and then cooled carefully. Properly tempered chocolate is smooth and glossy and produces smooth texture in mouth with good flavour and aroma.

D. ARECANUT (*Areca catechu* L.)

Arecanut is one of the most important commercial crops in South East Asia and is cultivated primarily for its kernels chewed in tender, ripe or processed form. Arecanut palm belongs to family Palmae. India is the leading country in production contributing to 51% of World's total production followed by China (25%). The arecanut is used as raw or in processed form as it is an essential component of gutka and pan masala, whereas, chali supari or kalipak are some of the value added products. Kalipak is prepared from immature green nuts and chali is prepared from ripe nuts.

Preservation of arecanut: In Assam, fresh fruits are preserved in thick layer of mud and this product is known as 'Bura Tamul'. In Kerala, fresh fruits are stored by steeping in water and the product is called 'Neettadakka'. The inner core is well preserved by this method but discolouration of outer husk and foul smell due to bacterial attack are some drawbacks. Preservation of ripe nuts after initial heat blanching in a solution containing sodium benzoate (0.1%) and potassium meta-bisulphite (0.2%), acidified to a pH of 3.5 to 4.0 with HCl helps in eliminating the foul smell and improves the quality of nuts.

Processing of arecanut

1. Dried ripe nuts (Chali or kottapak): The dried whole nuts of arecanut are known as Chali or kottapak. The ripe nuts are dried in open sun for 35-40 days up to 12% moisture content and the marketing of whole nuts is done after dehusking. Dehusking can be done with manually operated dehusker developed by CPCRI, Kasargod.

Depending upon the size, different grades of arecanut in decreasing order are moti, srivardhan, jamnagar and jini. Sometimes the fruits are cut longitudinally into 2 halves and are sun dried for 10 days. The kernels are scooped out and are given a final drying. The product is known as Parcha, which is popular in Kerala and Karnataka. Drying in mechanical drier takes 60-70 hours at 45-75^{0}C.

2. Kalipak: This product is famous in Kerala and Karnataka. Tender nuts are dehusked, cut in to pieces, boiled with water or a diluted extract from previous boiling, coated with kali and dried. Kali is a concentrated extract obtained after 3-4 batches of boiling of arecanut. The kalipak is known by different names depending on number, shape and size of the cuts. Api or Unde (without any cuts), batlu (transverse cut into halves), choor (several longitudinal cuts), podi (both longitudinal and transverse cuts) and erazel (transverse thin slices).

Lylon is another product made from green nuts which are cut transversely into 5-6 discs without kali coatings. A well dried product with dark brown colour, glossy appearance, chewing feel and absence of over-mature nuts are rated superior.

3. Scented supari: It is made both from chali and kalipak. Chali supari is more popular. The dried nuts are broken into bits and blended with spices for flavour and packed in butter paper. Saccharin is occasionally used for sweetening. Rose essence is commonly used for flavouring of supari. The scented supari is packed in aluminum or butter paper pouches for marketing.

E. CASHEWNUT

Cashewnut (Anacardium occidentale L.) is a tropical evergreen fruit tree belonging to Anacardiaceae family. It is widely cultivated in tropics for its nut and is a native of Brazil. In India it was introduced in Goa from where its cultivation spreaded to other parts of country. Cashew is a versatile tree nut and its kernel contains fats, proteins, carbohydrates, minerals and vitamins. Cashew has become number one crop in the World over almond. India provides around 55% supply of cashew kernels in World. The important commercial products of this crop are nuts and apple.

The cashew kernels are used in confectionary and deserts. Cashew apple is eaten fresh or mixed in salads and even a drink is prepared from its juice. Cashew can be distilled to produce alcoholic drink called as Fenny. The cashew shell contains oil known as cashew nut shell liquid (CNSL) which has wide industrial uses. In India, the cashew processing is done manually, which consists of moisture conditioning, roasting, shelling, kernel drying, peeling, grading and packing.

Processing of cashewnut

I. Processing at orchard level

The cashew processing in the orchard is mainly confined to removal of raw nuts from cashew apple and drying. The fully matured nuts are harvested and the apples are removed. The nuts are dried for 2-3 days to reduce moisture from 25% to below 9%. Drying helps the kernels to retain their quality particularly flavour.

II. Processing of raw nuts

The nuts used for processing are dried again to reduce moisture level to 7-8%. The steps involved in processing of raw nuts are as under:

1. Cleaning and grading of nuts: The nuts are cleaned and graded into three sizes, viz, small, medium and large. The grading of nuts is done on basis of nut thickness and not on the basis of its length. It helps in reducing the kernel breakage.

2. Roasting of nuts: Roasting of raw nuts is done to separate the adhering shell from kernel. There are three types of roasting viz; drum roasting, oil bath roasting and steam roasting.

a) **Drum roasting:** This is one of the oldest and more widely used methods. The nuts are fed into red hot rotating drum which will ignite the shell by maintaining its

temperature because of burning of shell liquid. The drum is kept in rotation for 3-4 minutes and roasted nuts are discharged from lower end of drum and immediately covered by ash after sprayed with a little water, to absorb oil on surface. This facilitates removal of remaining oil on shell.

b) Oil bath roasting: The conditioned nuts are passed through CNSL (cashew nut shell liquid) bath heated to 170-200C by conveyer buckets for 1-2 minutes. During this period the shells gets heated thus rupturing the wall and releasing oil into bath. The roasted nuts are then centrifuged to remove adhering oil, cooled and shelled by hand or leg operated shelling machines. The kernel with adhering testa is scooped out using a sharp needle. The method is followed traditionally in Kerala and Karnataka.

c) Steam roasting (autoclaving): The raw nuts are steam cooked at about 120-140 psi pressure to loosen the kernels from shells. Shell oil can be extracted in later stages by crushing. The nuts are shelled by hand or leg operated shelling machines. The steamed nuts are spread on floor under natural air for 12-24 hrs for cooling.

3. Shelling of nuts (decortications): Cashew nut after roasting and cooling are shelled to remove kernels. Care should be taken to protect hands from Cashew Nut Shell Liquid (CNSL) which is highly corrosive. Hand gloves can be used while shelling. Nuts are knocked 2-3 times on long edge of wooden mallet or light hammer to release the whole kernels without any damage. Foot operated shell cutter can be used for shelling. This device consists of a pair of blade (knives) shaped in counter of half a nut. The blade cut through the shell all around the nut, leaving the kernel untouched. A hand lever is pressed to open shell into two parts. The kernel is then scooped out manually.

4. Separation of kernels: After shelling, the kernel and shell pieces are separated manually and the separated kernels are collected into containers.

5. Pre-grading: Pre-grading can be done before and after drying kernels. It can be done mechanically for large scale processing, whole kernels are separated from the broken. Sometimes the whole kernels are also separated and graded according to the kernel size.

6. Drying of kernels: After removal from the shell, the kernels are dried at about 70-80^{0}C imperforated trays for about 6-8 hrs for reducing the moisture level to 4-5 percent. Drying of these kernels is necessary to prevent fungus. In order to ensure uniform drying, the position of tray may be changed frequently. Excessive drying may result in scorched kernel. After drying kernels are kept in the moist chamber for 24 hours which facilitates easy removal of testa and minimizes broken kernels.

7. Peeling: It is done by using a sharp knife or bamboo piece to remove testa (seed coat) from the kernels.

8. Grading of kernels: Kernels are graded according to the size manually. 25 different grades of cashewnut kernels are approved by Government of India. Standard specification for Indian cashew kernels are:

- **Wholes:** White wholes(WW)/scorched wholes(SW)/ dessert wholes (DW)
- **Broken :** White broken/scorched broken/dessert broken
- **Lower grades:** Rejection etc.

Further, the classification refers to broken kernels, splits, pieces, small pieces and whether kernels are white or scorched. The cashew kernels are sold as WW 180, WW210, WW240, WW450 and WW500 which means white whole with number of kernel per pound weight. Thus WW210 means white whole with 210 kernels/ lb weight. Similarly scorched wholes are numbered as SW180-SW500. Dessert wholes (DW), white pieces as B (Butts), S (Splits), LWP (Large white pieces), SWP (Small white pieces), BB (Baby bits), Scorched pieces as SB (Scorched butts), SS (Scorched splits), Dessert pieces as SPS (Scorched pieces seconds), DP (Dessert pieces).

- **Packaging of kernels:** The import trade requires packaging of kernels in 11.34 kg capacity (25 lbs) tins/airtight cans in which the kernels are kept. After filling and weighing, the tins are evacuated and filled with CO_2 with help of vita pack process. This consists of removing all air from can and substituting it with CO_2 and the holes in the cans are then sealed. Cashew should be packed in impermeable packages, as they become rancid and go stale quickly.

III. By-Products from cashew

1. Cashew apple: Cashew apple is a swollen peduncle to which nut is attached. It is very juicy and sweet, it is not eaten raw because of its astringent and acidic taste. It is very rich in vitamin C and can be used for juice extraction.

2. Cashew juice: The juice can be extracted with screw press, basket press or hand press. Straining of extracted juice is done through muslin cloth which is then clarified by adding 1.4g of PVP (Poly vinyl pyrolidine) per litre juice; the mixture is stirred and again strains through muslin cloth. Add sugar to improve the taste, and boil the juice. Fill hot in pre-sterilized bottles, crown cork and process on boiling water for 20-25 minutes. On cooling, keep in cool and dry place. Sodium benzoate can be used as preservative.

3. Cashew apple jam and candy: Immerse the cashew apples in 3% salt solution for 3 days to remove astringency (tannins), followed by steaming for 15-20 minutes. Extract the pulp and prepare jam as per standard practice. In case of candy the sugar strength is kept 45^0Brix and is increased @ 50Brix for 4 days and then @ 100Brix for 6^{th} and 7^{th} day so that the final strength of syrup reaches to 700Brix. Keep in this solution for 8-10 days for complete absorption of sugar. Remove the pieces from syrup and dry.

4. Cashew kernels peel tannin: Kernel peel are a rich source of tannin (25%), which is in great demand by leather industry.

5. Cashew Nut Shell Liquor (CNSL): It is a byproduct obtained during separation of cashew kernel. It is viscous dark liquid and is extremely corrosive. It is used as raw material for phenolic resins and friction powder in automobile industry. It is also used as moulding acid resistant paints, found in any resins, varnishes and as insecticide/ fungicides etc.

6. Cashew kernels oil: Low grade kernels are processed in to kernel oil (30-40%) which is of high quality.

7. Cashew kernel butter: Kernel residue after extraction of kernel oil used to produce cashew kernel butter which is similar to peanut butter.

F. COCONUT

Coconut (Cocos nucifera L.) is most useful palm belonging to family Palmae. In India, coconut tree is called as kalpvriksha the tree of life, coconut is grown in a

wide range of agro-climatic conditions. Productivity of coconut in India in terms of nuts/hectare is highest among major coconut growing area. Coconut is mainly consumed as raw nuts, copra and oil, whereas other products are coir and nuts. Coconut oil is the main commercial product. Copra obtained after drying kernel of coconut contains 65-70 % oil.

Copra is used to extract coconut oil and coconut meal in the ratio of 3:2. The products like hair oil, soaps, shampoos and medicine use coconut oil as a main ingredient. In India, only 10% of the production is used for tender nut water. Traditionally, coconut industry in India is centered on copra making, coconut oil extraction and coir manufacture. The industrial products are desiccated coconut, cream milk powder, vinegar, nata-de-coco etc.

Coconut Products: following products are made from coconut on a commercial scale.

1. Copra
2. Coconut oil
3. Raw kernel
4. Coconut cake
5. Tender coconut water
6. Coconut toddy
7. Coconut shell based products
8. Coconut wood based products
9. Coconut leaves
10. Core pith

1. Copra: The dried coconut endosperm is called copra with oil content of 65% to 70% copra is the richest source of fat. The focus of copra are made in our country namely milling copra and edible copra, milky copra is made in the form of cups used for oil extraction. It is also used as a dry fruit for consumption. Whole, edible copra is shredded and used as garnish in various dishes.

Drying of copra can be carried out in open sun or in hot air driers. Even electrical and solar driers can also be used. Sun drying takes 6-8 days while hot air driers involve 20-24 hours for drying. During drying the moisture content from 50-55 % is reduced to 5-6 %. Dried copra should be packed in polyethylene lined gunny bags and stored ion cool and dry place.

- Copra: it is made in the form of cups and balls.
- Ball copra: Fully ripe nuts of 12-14 months are stored in upper floor of specially made store (two storied brick and mortar building). The floor and four sides of upper story and smoked by a slow fire set under the platform using coconut palm waste. During this period, the water inside the nut dries up and kernel gets detached from shell and raffles on shaking. The process completes in 8-12 months. Small sized nuts are preferred over large sized one.
- Edible cup copra: Nuts stored as above for shorter period are used for making edible cup copra. The copra balls are cut into halves and then they are sun dried for a few days.

2. Coconut oil: Coconut oil is extracted from milling copra. The pulped copra is fed continuously to the expeller from which oil and cake are expressed. Hydraulic pressing of cake also results in extraction of copra oil. Coconut oil is very low in unsaturated and polyunsaturated fatty acids, particularly linoleic acid as compared to other vegetable oils (Kumar et al. 2000). It is more resistant to oxidation than many other types of oils.

It is obtained from mature meet which when dried contain 65% oil and the oil obtained from coconut milk is called as virgin coconut oil. Coconut oil is used for culinary, edible purposes and for industrial use like toiletries and soap making etc. Coconut oil processing methods are classified into two major types: dry and wet processes. When the oil is extracted from copra as raw material is termed as dry process, while use of fresh coconut as starting material is called wet process.

3. Coconut water: Water from tender coconut (7-8 month old) is a refreshing drink, effective in cases of gastroenteritis, diarrhea, vomiting and in preventing dehydration. The nut water is less nutritious from mature coconut as compared to tender coconut water. Nata-de-coco, soft drink, vinegar, food yeast etc are the products in which coconut water is main source. Coconut water can also be used to produce carbonated and non-carbonated beverages as refreshing and more nutritious drinks than other similar products.

4. Coconut meat: The kernel of seven to eight month old nut is very soft with maximum contents of protein and sugar. Kernel is as such consumed or with sweet nut water. Fresh kernel is consumed in the grated form and in the form of milk or

cream obtained by squeezing the grating with or without addition of water. As the nuts turn more mature the quality decreases gradually. Fresh coconut meat contains 50-55% moisture which is to be brought down to 5-6% during drying.

5. Coconut milk or cream: Coconut milk or cream is the oil-protein-water emulsion obtained by freezing grated fresh coconut kernel. It is the processed milk extracted from fresh matured coconuts. It is the processed milk extracted from fresh matured coconuts. It is used either directly or diluted with water to make various preparations like curries, sweets, puddings and many bakery preparations. Processed and packed coconut cream has a shelf life up to three months.

Instant coconut milk powder: It is a spray dried product similar to dairy milk powder. The spray dried coconut milk powder if dissolved in water, results in coconut milk which can be used in place of fresh coconut milk for food preparation.

7. Desiccated coconut (DC): Desiccated coconut is the white kernel of fresh coconuts, shelled and dried to about 2.5% moisture content with high nutritional value. The common grade of desiccated coconut has particle size less than 5 mm. It is an important commercial product with a wide demand in confectionary and other industries, like chocolate and liquorice. The desiccated coconut contains moisture 2.5%, oil 67.5%, protein 5.9%, carbohydrates 5.9%, ash 9.3% and fibre 2.4 percent.

8. Coconut husk products: The coconut husk usually forms 35-45% of the whole nut weight at ripening. About 30% of husk is fibre and 70% is the coir dust. Coir pith is used as manure, as mulch or in making briquettes with good export potential. Coconut husk is the basic raw material for coir industry. The fibres extracted from coir is used for spinning into yarn for making mats, ropes, rugs, carpets, bleaching, dyeing, printing, poly coir, coir matting, decorated boards, husk particle boards etc.

9. Coconut shell powder: it is made from matured coconut shells and is used in plywood and laminated board industry as a phenolic extruder and as filler in synthetic resin ghees, mosquito coils and agarbatis.

10. Other products: Coconut sap, coconut syrup and sugar, fermented coconut sap, coconut vinegar, coconut shell powder, coir fibre and pith are some of the important coconut products.

VALUE ADDITION IN FLOWERS

Value addition in flowers is a good source of income by self-employment. It includes fresh flower products from cut flower arrangements like bouquets, baskets, bunch, buttonaire, corsage etc. and secondly loose flower products like garland, floral strings, pomanders, wreaths, floral jewelry. Dry flower value added products includes dried flower arrangements, products of press dried flowers and pot pourries etc. Processed products include essential oils, absolutes, concrete, petal jam (rose, rhododendron), jelly, ready to serve beverages, wine, floral tea, rose hip juice, poultry feed, insect repellent, floral dyes, petal embedded handmade paper, cosmetics like calendula cream, rose water, rose cream etc. Value addition in floriculture also covers novel innovative products and technologies such as floral genes, novelty for molecular breeding, flower form, flower colour, floral fragrance and modern gardening.

Flowers give the opportunity to convert them into remunerative value added products directly from fresh flowers like garland, bouquet, flower arrangements or after drying the flowers making different dried flower products like pot pourri, wreath, painted gourds, greeting cards or after processing like rose water, gulkand, gulroban, perfumes, essential oil, insect repellants, cosmetics, etc. Besides,a number of pigments like xanthophylls, carotenoids, luteins, anthocyanins, etc. which have neutraceutical properties and pharmaceutical compounds can also be prepared from the flowers. It is a good source of income generation by self- employment. The value-added products can be classified into three categories namely 1. Fresh Flower Products, 2. Dried Flower Products and Processed Flower Products.

1. Fresh flower value added products

It includes two types of flower arrangements; firstly, cut flower arrangements like bouquets, baskets, bunch, buttonaire, corsage etc.; secondly loose flower products like garland, floral strings, pomanders, wreaths, floral jewelry etc.

Cut Flower arrangements

Flowers like roses, carnation, chrysanthemum, lilium and other high value crops are suitable for making different type of flower arrangement. The flower arrangements can be Japanese style of arrangements namely ikebana, moribana; English style like upright, slanting, regular, irregular, curved shape, Hogarth S shape etc.

Flower Bouquets

A flower bouquet is the collection of flowers in a creative arrangement. Flower bouquets are arranged for the decor of homes or public buildings, or may be handheld. Handheld bouquets can be classified by several different popular shapes and styles, including nosegay, crescent, and cascading bouquets.

Rangoli

Generally, the rangoli means drawing patterns at the entrance is made up of colours but keeping in view the ecofriendly nature, the loose flowers can also be used to make rangoli. In place of artificial colours, flowers of different colours are used; to create green colour either turf grass clippings or foliage clippings are used.

Garlands

Garlands are prepared by using only one type of flower or a combination of different flowers. Generally, sweet scented flowers such as jasmine, tuberose, gardenia etc. are preferred for making a garland.

Floral bangles

Floral bangles made of fragrant flowers like jasmine or tuberose or non-fragrant flowers like *Tabernaemontana*, marigold and *Thevetia peruviana* worn by female dancers

Floral crowns

Floral crowns made of scented tuberose flowers are usually used in ceremonies like 'Annaprasna'or by a queen or a princess in a drama.

Floral earrings and Bajubandh

Floral Earrings and Bajubandh are worn by women in dance ceremonies to remember epic heroes and heroines such as Rama and Sita. Flowers like tuberose, kadamba, jasmine etc. are used for this purpose.

Veni

Special kind of flower arrangement is commonly used in South India to decorate long plait of hair during ceremonies at the time of marriages or Bharat Natyam dance recital.

Wreath

It is a band of flowers or foliage intertwined into a ring, usually placed on a grave as a memorial or worn on the head as a crown or a mark of honour.

Buttonhole/ boutonniere

These are generally worn by both man and women. It is a miniature flower arrangement prepared by using single small flower like rose or orchid along with filler like thuja leaf.

Corsage

A flower or small arrangement of flowers worn by a person as a personal ornament. It is usually larger or more elaborate than a boutonniere.

2. Dry Flower Value Added Products

Dry flower value added products includes dried flower arrangements, products of press dried flowers and pot pourries etc.

Dry flower arrangement

Dry flowers are arranged in dry vases just as fresh cut flowers are arranged. They can be arranged in bouquets or wall displays after fastening them to decorative bands. Flowers like Helichrysum, Delphinium, Helipterum, Amaranthus, Nigella, Carathmus, Gypsophilla and Rosa can be dried by different methods of drying in making the dried flower products and flower arrangements.

Floral Jewelry

Orchid flowers are widely used in Thailand, Singapore and Malaysia to electroplate with gold and platinum to make exquisite jewelry. India has enormous potential with orchid species and hybrids like Dendrobium, Phalaenopsis, Cattleya, Oncidium, Arnada, Mokara, Vanda, Pholidota etc. to diversify into such avenues to exploit the vast genetic resources and expert craftsmanship available in the country.

Floral gifts

The advancement of internet and cheap air travel facilities have opened up the avenues to place and deliver floral arrangements as personal gifts across the country.

Pot pourri

It is a mixture of dried, naturally fragrant plant material, used to provide a gentle natural scent in houses. It is usually placed in a decorative wooden bowl, or tied in small bags made from sheer fabric. Dried flowers are used as a common component of potpourris. Rose petals, gomphrena, marigold petals, lotus pods, are ideally suitable for making pot pourris.

Candle making

Dry flowers can also add beauty to the candles. It can be done by just adding dried flowers to the outside of plain candles or simply placing crushed dried flowers on wax paper and then pouring a little melted wax over the flowers followed by rolling the candle in the flowers.

Press dried flower products

It includes greeting cards, bookmarks, paper weights, wall hangings, table tops, table mats, etc. The flowers and leaves are dried by herbarium method and finally pasted with fevicol or glue in artistic manner.

Petal embedded handmade paper

It is made with all wood free materials and real flower petals are embedded in the paper during the making process. This gives the paper that exclusive look. On beautiful textured handmade sheets petals are embedded which adds grace and beauty.

3. Processed Flower Products

Processed products include essential oils, absolutes, concrete, petal jam (rose, rhododendron), jelly, ready to serve beverages, wine, floral tea, rose hip juice, poultry feed, insect repellent, floral dyes, petal embedded handmade paper, cosmetics like calendula cream, rose water, rose cream etc.

VALUE ADDITION IN MEDICINAL AND AROMATIC PLANTS (MAPS)

Introduction

Since time immemorial plants are used for healing purposes in various systems of folk medicines and still 80 percent of the population in developing countries relies largely on plant based drugs for their health care needs. Nearly, thirty percent of the drugs sold worldwide contain compounds derived from plant origin. There is an expanding interest in medicinal and aromatic plants (MAPs) as new income generating opportunities are opening up for rural populations and many extremely poor households who collect MAPs from wild and sell which provide complementary source of cash for them. However, despite the fact that the raw drug collected can have very high value in the final products, the collectors and cultivators typically receive only a small share of the final value, either because they are unaware of the real value, or unable to market it in the form wanted by buyers or are unable to market to these buyers. In fact, many stakeholders at the bottom are not aware of the rising demand of their product and the opportunities existing in local and international markets. Such markets like Europe and the United States are highly regulated and very difficult to penetrate.

In the case of India, around 80 percent is exported as raw materials including dried plants, extracts and isolated ingredients. The export of finished medicinal products, mostly homoeopathic and ayurvedic medicines, accounts for the remaining 20 percent. With large population and ancient heritage of traditional herbal- based medicines India is one of the world's largest markets for medicinal plants and the opportunities are abundant for substantial income generation for those dependent on MAPs within our country or in the world markets through value added products of MAPs.

Importance of value addition in Medicinal and Aromatic Plants

In the World, trade on MAPs is dominated by 12 countries such as USA, Germany, Hong Kong, China, India, Japan, Korea, Albania, Bulgaria, France, Chile and Mexico are the major players. Lower prices per unit traded commodity indicate that mainly raw plant material of wild-collection origin is exported . The benefit is relatively low. Consequently, only unemployed or unskilled people or people with

low wages are collecting botanicals. Often wild-collection results in low income level for the collectors who are either ignorant to the market value of the materials or exploitation by the companies or the contractors/middle men involved in the trade. Often, consumer countries tend to buy from low-price countries to increase their own trade profit. To get the right share of benefit from our herbal wealth, it is imperative for all the stakeholders of MAPs industry to put maximum thrust on value addition in all aspects, starting from collection/cultivation to products, the consumers use.

Strategies for value addition in MAPs

The existing system of medicinal plant collection or cultivation in India needs substantial improvements for the harnessing the full potential of this important industry. Improvements are needed especially in the areas of post *collection handling, processing and product presentation*. The following direct or indirect value addition techniques shall be followed without much capital to increase the value of medicinal plant materials and reduce the contamination and wastages. Considering the complexity of the herbal products range, wide spectrum of medicinal and aromatic crops, individual cases are not dealt here.

I. Direct Value Addition

- *Collection at right season and at right maturity*: To get the right composition of phyto-chemicals or essesntial oils, collection/harvesting should be carried out at appropriate stages and seasons.
- *Grading and sorting*: Basic procedures like grading, sorting are effective means of getting higher value for the produce with minimal efforts.
- *Cleaning*: Cleaning technique should be followed to remove unwanted foreign materials and pollutants
- *Proper drying*: Depending upon the needs, the drying has to be carried out to retain the desired quality and to avoid losses.
- *Packaging*: Keeps contents from extraneous matter or from loss of the material under normal conditions of handling, shipment or storage. Different categories of the plant materials require different packaging considerations.

II. Indirect Value Addition

- Quality testing for purity and strength
- Organic certification: Of more than400 plants species used for production of medicine by the Indian Herbal Industry, fewer than 20

species are currently under cultivation in different parts of the country. Organic cultivation of selected medicinal and aromatic plants and certification can be profitable to cultivators with buy- back arrangement with buyers or user industries.

III. Semi-processing of the medicinal plants to value added products:

- Semi processing like producing powder, tablets and extracts of herbal materials does not require very expensive processing machineries and can be carried for many of the herbs available locally based on the demand. The required technical knowledge in this area is available freely.

Value addition through processing of Medicinal and Aromatic plants

The industrial processing of medicinal and aromatic plants starts with the extraction of active components using one or other technology.

Essential oils extracted from aromatic plants contain heterogeneous mixture of widely varied chemical constituents and hence the technology used vary widely and the best results are obtained by modifying and adapting the general extraction process to a particular aromatic plant. The general techniques of extraction of medicinal plants include maceration, infusion, percolation, digestion, decoction, hot continuous extraction (soxhlet), aqueous-alcoholic extraction by fermentation, counter current extraction (CCE), microwave assisted extraction, ultrasound extraction (sonication), supercritical fluid extraction (SFE), phytonic extraction (with hydro-flouro-carbon solvents), etc. Consequent to the processing steps, the value per unit material increase sharply (Fig. 2)

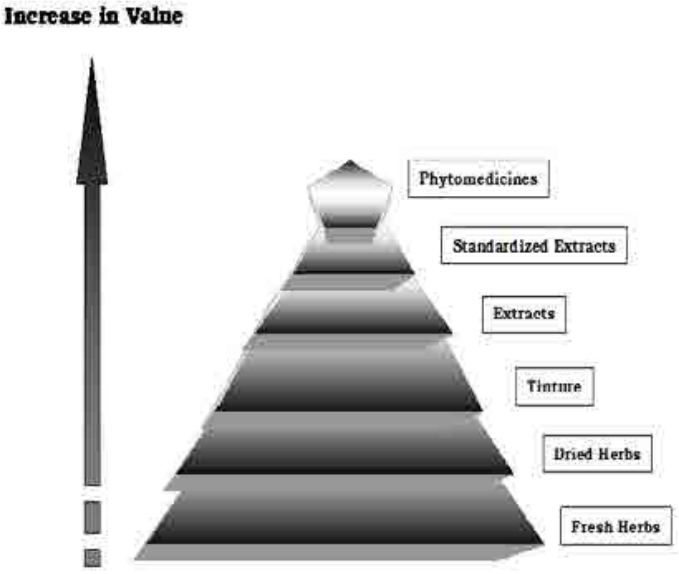

Fig. 2. Increase in value of medicinal plant during processing steps.

Constraints associated with the processing of medicinal plants

The processing of raw materials collected from wild or from commercial cultivation is hampered by various difficulties. The problems associated with lack of Good Agricultural Practices (GAP) including poor harvesting and post harvest practices, lack of domestication and genetic improvement, inefficient processing techniques with low yields, poor quality control, higher energy consumption during processing, lack of Good Manufacturing practices (GMP), lack of R& D on product and process development, marketing related problems, lack of market for primary processed products, lack of trained personnel and right equipments, lack of local fabrication facilities and lack of latest technological and market information are some of the difficulties faced by the collectors or cultivators encounter in addition to the financial / resource crunch for value addition in MAPs.

Extraction of essential oils and value addition in aromatic crops:

Technology for processing aromatic crops is quite simple and all the required machineries and manufacturing facilities are available in most parts of our country. As these extraction plants can be made locally, commercial cultivation would be viable in many parts of our country with participation of even small group of farmers. For sustainable utilization of the extraction unit, the raw materials will be available through these types and farming clusters. Following are some of the types of extraction methods available for essential oil extraction from aromatic plants. The type of method will be chosen based on the resources available and requirements as decided by the type of material used and other considerations.

Extraction methods for Essential oils

I. **Distillation**

1. Hydro distillation, 2. Steam distillation, 3.Hydro diffusion.

II. Other specialized distillation

1. Cohobation, 2. Rectification, 3. Water & steam distillation, 4. Fractional distillation.

III. **Expression**

1. Sponge expression 2. Machine abrasion,

IV. **Solvent extraction**

1. Maceration, 2. Enfleurage, 3. Supercritical carbon dioxide CO2.

Most citrus peel oils are expressed mechanically, or cold-pressed, since peel contains large quantities of oil and relatively low cost to grow and harvest the raw materials. Prior to the discovery of distillation, all essential oils were extracted by pressing. Most flowers contain too little volatile oil to undergo expression and their chemical components are too delicate and easily denatured by the high heat used in steam distillation. Instead, a solvent such as hexane or supercritical carbon dioxide is used to extract the oils. Supercritical carbon dioxide is used as a solvent in supercritical fluid extraction. This method has many benefits, including avoiding petrochemical residues in the product and the loss of some "top notes" when steam distillation is used. It does not yield an absolute directly. The supercritical carbon dioxide will extract both the waxes and the essential oils that make up the concrete. Subsequent processing with liquid carbon dioxide, achieved in the same extractor by merely lowering the extraction temperature, will separate the waxes from the essential oils.

Advanced processing of Medicinal Plants

For the production certain drugs, primary processing of parts of plants containing the intermediates could be carried out restoring some value of the resource material. For example, diosgenin (from *Dioscorea* sp.) and hecogenin (from sisal) used in the production of steroids can be commercially produced. Processed products (galenicals) from plants could be standardised fluid/solid extracts or powders or tinctures can be prepared with considerable value addition to raw materials. Standardized extracts of many plants (e.g. *Aloe* species, *Atropa belladonna*, *Cassia angustifolia*, *Capsicum annuum*, *Centella asiatica*, *Cephaelis ipecacuanha*, *Digitalis* species, *Commiphora waghtii*) are widely used in health care.

MEDICINAL PROPERTIES AND USES OF MORINGA LEAVES

Among the Green Leafy Vegetables (GLV),*Moringa oleifera* contains all essential nutrients, enzymes, omega oils, minerals, antioxidants and phytochemical compounds.It is the most important nutrient rich plant of the planet. Moringa leaf is an outstanding source of nutritional components. The dried moringa leaves have the calcium, equivalent of 17 times of milk and the vitamin C content is seven times than that of oranges. While its potassium is 15 times than that of banana, 25 times the iron of spinach, and10 times the amount of vitamin A in carrots and 9 times the protein content in yoghurt. It has much impressive range of medicinal uses with higher nutritional value.

It has a potential effect for a healthy cardiovascular system, promote normal blood glucose level, neutralize free radicals, provide excellent support for anti inflammatory mechanism, enrich aneamic blood and support immune system. It also improves eye sight, mental alertness and bone strength. It has potential benefit in malnutrition, general weakness, lactating mother, menopause depression and osteoporosis.

Moringa leaves provide a nutritional supplement around the World. The leaves can be eaten as a vegetable. The leaves can also be dried and stored for many months under ambient conditions with minimum changes in nutritional value. The leaves can be dried and converted into powder, as a food supplement. The powder or dry leaves can be added to any dish to enhance the nutritional value of the products. The technology on processing of moringa leaf powder is simple and it is convenient to store and use.

Moringa rice mix

Moringa puttu mix

The moringa leaf powder finds suitable applications in all the South Indian recipes like roti mix, chappathi mix, cookies, soup, rice mix and juice mix. It has projected great demand in the national and international market.

Moringa Noodles

Moringa soup

Moringa licks

Promotion of moringa leaf incorporated foods would help not only for alleviating micro nutrient deficiencies but also to develop entrepreneurship which could provide an additional source of income, employment and exports to the farmers, entrepreneurs and processors.

FOOD SAFETY STANDARDS AND QUALITY ASSURANCE OF CONVENIENCE FOODS

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Convenience foods are typically commercially prepared foods designed for ease of consumption. Products designated as convenience food are often prepared food stuffs that can be sold as hot, ready-to-eat dishes; as room-temperature, shelf-stable products; or as refrigerated or frozen food products that require minimal preparation (typically just heating). Convenience foods have also been described as foods that have been created to "make them more appealing to the consumer. Convenience foods and fast foods are similar, because the development of both occurred to save time in the preparation of food. Both typically cost more compared to the price of preparing the same foods from scratch.

Convenience food are tertiary processed foods or foods which are designed to save consumers time in the kitchen, reduce costs due to spoilage, and reduce costs using economies of scale. Some convenience foods can be consumed instantly or some after the addition of some water, heating or thawing.

The convenience food segment covers a very narrowly defined range of foods such as ready-to-eat meals and soups. However, it does not include products such as frozen vegetables, freshly prepared salads, and cut fruit.

Classification of Convenience Foods

Convenience food, or tertiary processed food, is commercially prepared food designed for ease of consumption**.**

Ready-To-Eat (RTE) Foods

Such foods are edible and do not require additional heating/freezing treatment to make them safe to eat. They are ready for consumption, need only to be reheated and consumed. For example, long keeping/short-term preserved/preserved and flavoured/retort processed/frozen chapattis, composite breakfast cereal bar, RTE soy chunk, intermediate moisture fruits, and so on.

Ready-To-Cook (RTC) Foods

These foods are edible and require additional heating/freezing treatment to make them safe to eat. For example, Instant Curried Dhal mix, Instant Pulav mix, Instant Khichidi mix, Instant Basmati rice, Instant whole legumes like Kabuli channa, Rajama, and Whole grams.

Water is added to the Ready to cook products and cooked before consumption. e.g., Macaroni, Spaghetti, Vermicelli, Noodles, Suji-halwa mix, Ready upma mix, Instant curried dal mix, Ready kichdi mix, Ready vegetable pulav mix, Ready idli mix.

Ready to fry products: Water is added to these products and fried in vegetable oil. Sometimes followed by immersing in sugar syrup; e.g., Instant Jamun mix, Instant Rasagolla mix.

Ready-To-Serve (RTS) Foods

Such foods can be directly consumed from the container and mainly include beverages. Forexample, juices, squashes, purees (tomato, mango), soft drinks, packaged milk (flavoured milk, pasteurised milk), lemonade, fruit beverages, and energy drinks.

Types of Convenience foods:

Convenience foods can include products such as candy; beverages such as soft drinks, juices and milk; fast food; nuts, fruits and vegetables in fresh or preserved states; processed meats and cheeses; and canned products such as soups and pasta dishes. Additional convenience foods include frozen pizza, chips such as potato chips, pretzels a and cookies.

These products are often sold in portion controlled, single serve packaging designed for portability.

Products available in the market:

I. Instant foods for breakfast: kesari bath, upma, vada, pav-bhaji (frozen), idly, dosa etc.

II. Instant foods for lunch/dinner: Today, almost any South Indian or North Indian staple dishes are available in the Heat and Eat category. e.g., vegetable curries such as Palak Paneer, Aloo Mutter, Navaratan Kurma, Bhindi Masala, Mixed Vegetable masala, Rajma/Cholay Curry etc.

III. Preserved Chapathis and Parottas

IV. Dals such as Dal Makhani, Dal Fry

V. Rice preparations such as Plain Rice, Curd Rice, Vegetable Pulav, Kichadi, Bisi-bele- bath (combination of Rice and Pulse).

VI.Desserts such as Moong ki Halwa, Carrot Halwa, Payasams

VII.Animal products such as Fish fry, Fish Curry, Chicken Curry, Mutton Curry, Shrimp Pulav, Mutton Pulav etc.

Therefore, virtually, any staple food catering to the tastes of any region in the country, comprising of the major food groups as the ingredients are available.

Benefits of Convenience Food

Time Saving: Convenience food reduces the time required for pre-preparation and to some extend even cooking time required. Hence, significant time can be saved where preparation from scratch for any meal can be avoided.

Variety: Due to the various techniques used in the convenience food manufacturing process one is able to get a lot of variety in the market. In fact the amount of variety available in the stores today does put a working woman in a fix on the choice that she needs to make. Another pointto be noticed is that this variety remains constant in the market and does go off shelf citing seasonal reasons like the fresh fruits and vegetables do.

Healthy: One can read the contents and detailing on the packaging of the convenience product and decide to whether heath aspects are preferred or not.

Convenience: these products are convenient to carry, stack and store them since their packaging are well planned considering various factors like consistency, texture, size and fragility.

Shelf Life: Most convenience foods have a longer shelf life due to additives and the same is also mentioned on the package hence the user is well informed of its usage period.

Storage: Storage of convenience foods is easy as they can be stacked up anywhere and can also help better utilization of the space available. Regeneration is also faster and better.

Labour Saving: Convenience food helps saving labour in the terms of going to market for purchase, pre-cleaning,pre-preparation and post preparation cleaning.

Food Safety: The new techniques used in the manufacturing and packaging of convenience like aseptic canning, rapid freezing, various methods of eradicating bacteria reduces its presence and also reduces spoilage of food to a great extent if stored properly.

Recipe Knowledge: Many a time the working woman does have requests from her own home or she herself wants to try preparing something of which recipe might not be known to her. Hence she looks out for such products for which she need not bother to know how to prepare it rather she would use the convenience of such available products.

Availability: Certain fresh products might not be available throughout the year due to their seasonal availability whereas convenience products are manufactured using stringent quality standards hence their availability besides being consistent also has consistent taste, texture and taste.

Food Safety *Food safety* means assurance that food is acceptable for human consumption according to its intended use. An understanding of food safety is improved by defining two other concepts — toxicity and hazard.

Food safety provides an assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use. Safety is a component of quality. Safety differs from many other quality attributes since it is a quality attribute that is difficult to observe. A product can appear to be of high quality, i.e. well colored, appetizing, flavorful, etc. and yet be unsafe because it is contaminated with undetected pathogenic organisms, toxic chemicals, or physical hazards. On the other hand, product that seems to lack many of the visible quality attributes can be safe. Salmonella contagion of peanut butter in the US, melamine contamination of milk in China and high pesticide content of aerated drinks manufactured in India – has significantly enhanced the concern for food safety and its impact on health, marketing and foreign trade. Protecting consumer health from food borne hazards has become a compelling duty for policy makers across the globe.

Quality Assurance

“Planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality”

Quality Assurance is a system for evaluating performance, service, of the quality of a product against system, standard or specified requirement for customers. Planned activity or systematic approach to provide adequate confidence of product and service. Quality assurance can be defined as "part of quality management focused on providing confidence that quality requirements will be fulfilled." The confidence provided by quality assurance is two fold—internally to management and

externally to customers, government agencies, regulators, certifiers, and third parties. An alternate definition is "all the planned and systematic activities implemented within the quality system that can be demonstrated to provide confidence that a product or service will fulfill requirements for quality."

Quality and safety of food products is regulated by Food Safety and Standards Authority of India (FSSAI), Govt. of India. Since standards for Instant foods are not laid down by FSSAI, such foods are considered as Proprietary foods. However, safety standards such as appropriate microbiological parameters such as Total plate count, coliform, *E.Coli* and other harmful bacteria are considered.

Also, the labeling aspects for pre-packaged foods as per FSSAI regulations are taken into account.

Methods suggested by ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS (AOAC) and other international procedures were adopted for testing the products for various chemical and micro biological characteristics.

(1) Packaging and Labeling

There are 12 parameters under this criterion

- Name of the product
- List of ingredients in decreasing order of the proportion by weight
- Names/INS No. of additives
- Nutritional label for macro nutrients such as protein, fat, carbohydrates, energy value per 100 grams as per BIS/Codex/AOAC methods
- Batch No
- Date of manufacture
- Best before Date or Expiry date
- Instructions for storage and preparation
- Address of Manufacturer
- Telephone No in case of consumer complaints, if any
- Any other label
- MRP

(2) Quality

i.Nutrition

- **Fat Content in g/100 g (AOAC Chapter 32, 18th Edition)**
- **Protein Content in g/100 g (AOAC Chapter 32, 18th Edition)**
- **Carbohydrates g/100 g (Pearson's Composition and Analysis of Food 9th Edition)**
- **Calories in kcal/100g (Pearson's Composition and Analysis of Food 9th Edition**
- **Nutritional Claims verification, if any.**

Claims such as presence of Iron and Calcium in some products wherever such claim is made, is verified by the laboratory tests.

ii. Chemical Characteristics (Verification by tests):

Moisture in % (AOAC Chapter 32, 18th Edition)

Moisture is measured in % and when it exceeds the prescribed limits results in lumping and caking of food leading to bacteria growth and spoilage of food.

Ash in g/100g (AOAC Chapter 32, 18th Edition)

This is measure of presence of unwanted gritty matter.

Acid insoluble Ash in g/100g (AOAC Chapter 43, 18th Edition)

This indicates the amount of such matter that is not digestible present in food.

Sugar in g/100g (AOAC Chapter AOAC Chapter 32, 18th Edition)

Too much sugar adds avoidable calories and too little can deprive from the required energy.

Acid Value of Extracted Fat in g/100g (AOAC Chapter 41, 18th Edition)

This is a measure to determining the deterioration of fat content in food leading to rancidity affecting essential nutrients and making the food unfit for consumption.

Uric Acid in mg/kg (Japan Society of Analytical Chemistry Dec 2008 Vol 4)

This is a measure of insect infestation or the purity of the product.

Preservative in mg/kg (Journal of Chromatography A 2004 1032)

Preservatives in foods are added to preserve the food and increase its shelf life. These are chemicals and should be restricted to permissible levels.

(3) Health and Safety

i.The Microbiological Characteristics were verified by test

Total Plate Count should not be more than **(NMT)** 50 CFU/g.

Coliform count – should be absent

Salmonella, Shigella, and E-coli should be absent.

ii. Incubation (Sterility) Test

Incubation at **37° C** for **10 days** and **55° C for 7 days** – no bloating of the pack should be observed.

Food Standards

Effective food standards and control systems are required to integrate quality into every aspect of food production and service, to ensure the supply of hygienic, wholesome food as well as to facilitate trade within and between nations. There are four levels of standards which are well coordinated.

a. Company Standards: These are prepared by a Company for its own use. Normally, they are copies of National Standards.

b. National Standards: These are issued by the national standards body, Food Safety and Standards Authority of India (FSSAI).

Regional Standards*:* Regional groups with similar geographical, climate, etc. have legislation standardisation bodies. d. *International Standards:* The International Organisation for Standardisation (ISO) and Codex Alimentarius Commission (CAC) publish international standards.

Food Standards and Regulations in India

Food Safety and Standards Act (FSSA), 2006 International Organisations and Agreements in the Area of Food Standards, Quality, Research and Trade

The major organisations which are playing a key role are:

1. Codex Alimentarius Commission (CAC)
2. International Organisation for Standardisation
3. World Trade Organisation

Food Safety Management Systems

- Good Manufacturing Practices (GMP)
- Good Handling Practices (GHP)
- Hazard Analysis Critical Control Points (HACCP)

HACCP is a means of providing assurance about safety of food. HACCP is an approach to food manufacture and storage in which raw materials and each individual step in a specific process are considered in detail and evaluated for its potential to contribute to the development of pathogenic micro organisms or other food hazards. It involves identification of hazards, assessment of chances of occurrence of hazards during each step /stage in the food chain — raw material procurement, manufacturing, distribution, usage of food products and defining measures for hazard(s) control.

Convenience Foods are well designed considering the requirement of the consumer. They are also made safe for consumption and also hold a good shelf life. Their storage conditions are also mentioned to ensure proper utilization of product in case of it not being utilized completely.