

Lesson 7

POST HARVEST PROCESSING-I

7.1 Storage of Fruits and Vegetables

Storage of fruits and vegetables is practiced for various reasons. It is part of orderly marketing where the storage period is usually short, to allow for accumulation of sufficient produce by the grower or group of growers to send to market. Certain fruits and vegetables are stored for longer periods of time to extend the duration of their availability. In some cases fruit and vegetables destined to be processed are first stored to even out the supply to the factory. Often the objective is to provide a constant supply of raw material for the factory for as long a time as possible. Often this type of storage is different from storage of fruits and vegetables destined for fresh market. Many types of storage systems are available for fruits and vegetables. Some of the important ones are given below.

7.1.1 Evaporative cooling and storage

In tropical countries like India deterioration in quality of fruits takes place immediately after harvest due to lack of on farm storage. To overcome this problem low cost, environmental friendly zero energy chambers also called as evaporative coolers have been developed. When water evaporates from the liquid to the vapour phase, it requires energy. This principle is used to cool stores or chambers by passing the air that is introduced into the store first through a pad of water. The degree of cooling depends on the original humidity of the air and the efficiency of the evaporating surface. These can be easily constructed at small and marginal farmers' field and are helpful to keep temperature 15-30°C lower than atmospheric temperature. These can be used for short-term storage of fruits and vegetables at the farmers' field.

7.1.2 Controlled and modified atmosphere storage

Normal atmospheric air contains about 78.08% of nitrogen (N₂), 21% of oxygen (O₂), 0.04% of carbon dioxide (CO₂) and remaining other gases. A reduction in the concentration of O₂ and/or an increase in CO₂ concentration of the storage atmosphere surrounding fresh fruits and vegetables reduce the rate of respiration and also inhibits microbial and insect growth. The terms “controlled atmosphere” (CA) and “modified atmosphere” (MA) mean that the atmospheric composition surrounding a perishable product is different from that of normal air. Concept of controlled atmosphere storage (CAS) of fruits and vegetables was given by J.Be'rard of France in 1821. However, commercial use of CAS grew out of the research of Kidd and West in 1917 on respiratory behaviour of fruits under modified atmospheres. It was applied commercially for the first time in 1927 for storage of fruits and vegetables. In-transit use of CA and MA has been developed much later, during 60's only. Both CA and MA commonly involve manipulation of CO₂, O₂ and N₂ levels.

The principle of CA or MA involves the complete or partial removal of air from the storage are and its replacement with a single gas or mixture of gases by either passive or active methods. Passive modification is a

slow process. It requires reactions between the fruit or vegetable and its surrounding gases to take place, and the package to play the role of a regulator. On the contrary, active modification is faster and can be achieved by gas flushing, vacuum application or by using gas scavengers / emitters. Passive MA relies on the selective permeability of the packaging materials to different gases and on product respiration and is traditionally used with fresh and minimally processed fruits and vegetables. Gas-flush MA involves the establishment of a specific gas composition within the package in a single stage during the packaging operation, by flushing with the selected gas mixture before sealing. Depending on the desired residual O₂, a vacuum operation may be needed prior to gas flushing. The gas mixture used is dependent on the type of fruit or vegetable. MA differs from CA only in how precisely gas partial pressures are controlled; CA is more precise than MA. When combined with chilling, CA or MA are increasingly important methods of maintaining high quality in processed foods during an extended shelf life. The following are some types of atmosphere-modification techniques:

a. *Atmosphere Generation*

Oxygen partial pressures can be reduced by purging with nitrogen, burning, using catalytic converters, or using silicone membranes. Water, lime, and molecular sieves have all been shown to be effective scrubbers for removal of CO₂. Pressurized cylinders or dry ice can be used for addition of CO₂ into the holding chamber. Carbon monoxide can also be added from pressurized cylinders.

b. *Hypobaric (Low-Pressure) Systems*

Hypobaric storage is a type of CA storage in which a product is held under a partial vacuum. By reducing the normal atmospheric pressure in the ambient environment around the commodity, the effective partial pressures of individual ambient gases are also lowered. For example, a one-fifth reduction in the total pressure of normal air would result in an effective oxygen partial pressure (oxygen tension) equivalent to 4% O₂. In addition to lowering the partial pressure systems allow gases to escape more rapidly. This is due to the fact that the diffusion coefficients of various gases, including ethylene and other volatiles are inversely proportional to atmospheric pressures.

c. *Commodity-Modified Atmospheres*

In this particular approach an actively respiring and metabolizing product reduces the O₂ and increases the CO₂ in the ambient air within a chamber in which various barriers and restrictions to gas exchange exist. Ethylene and CO₂ scrubbers are used when either of these components is considered harmful to the commodity. When a plant material is put in a CA/ MA chamber, composition of cellular environment also changes due to Devaux effect. Devaux effect defines that due to difference in concentration gradient of gases on the two sides of membrane, diffusion of gases from the higher concentration side to the lower concentration side take place till equilibrium is attained. It is caused by difference in concentration gradient of gases on the two sides of membrane. Diffusion of gases from higher concentration side to the lower concentration side takes place till equilibrium is attained. CO₂ from the tissues of plant and O₂ from the external environment to the tissues occur. Rate of diffusion of CO₂ is much faster than that of O₂. Commodity modified atmosphere can be attained by using various techniques such as wax coating, by putting plastic covers with diffusion windows, manipulation of shipping containers or vehicles, applying polythene liners in shipping containers, packaging in film wraps and using air-tight cold storage rooms. The barriers can be created by commodity itself, or using package or storage rooms.

7.1.3 Benefits of CA storage

- Very low levels of O₂ (<2%) and high CO₂ level (≥60%) can control insects.
- A considerable decrease in respiration rate, in climacteric maximum, accompanied by an expansion of both pre-climacteric and post-climacteric period.
- Reduction in effect of C₂H₄ due to its interaction with O₂ and hence delay in development and appearance of the symptoms of senescence.
- Increased flesh firmness due to inhibition of enzymes responsible for damage of cellular membrane, at high CO₂ level.
- High turgidity and hence more juicy & crisp fruits.,
- Superior sensory and nutritional quality.
- A limited degradation of chlorophyll resulting in greater colour stability.
- Some physiological disorders, such as chilling injury, spot, decay, browning, water core and scald are greatly reduced.
- Mould growth is low due to less O₂ and high CO₂.
- Longer storage life.

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Lesson 8

POST HARVEST PROCESSING-II

8.1 Introduction

Fruits and vegetables are important constituents of our diet and they serve as a vehicle of nutrients like vitamins, minerals, sugars and fiber. However, being harvested from farm or field they are prone to contain dirt, soil, bacterial contamination, extraneous matter making them unfit for direct consumption by consumers. Hence, processing interventions are necessary to make fruits and vegetables free from all the above mentioned materials. Also, their processing is required to increase their shelf life as well as to prepare a number of value added products from them. Fruits and vegetables are processed by various methods like low temperature, thermal treatment, concentration, freezing and irradiation. But prior to subjecting fruits and vegetables to such treatments, all fruits and vegetables undergo some preliminary operations. Each processing method is based on certain principles and each has its own advantages and disadvantages.

8.2 Post Harvest Preliminary Processing Operations

The preliminary processing operations of fruits and vegetables are sorting, grading, washing, peeling, sizing, blanching, etc. The importance of each operation is discussed below.

8.2.1 Sorting and grading

Sorting and grading are terms which are frequently used interchangeably in the food processing industry, but strictly speaking they are distinct operations. Sorting is a separation based on individual physical properties of raw materials such as weight, size, shape, density, photometric property, etc. while grading is classification on the basis of quality incorporating commercial value, end use and official standards. The selection of fruits and vegetables is important from processing point of view for the manufacture of a particular end product. The fruit should be ripe, but firm and evenly matured while vegetable should be tender and reasonably free from soil, dirt, etc. They should be free from blemishes, insect damage and malformation. Over ripe fruit is generally infected with microorganisms and would yield a poor quality finished product. After this preliminary sorting, the fruits and vegetables are graded. This is necessary to obtain a pack of uniform quality as regards size, colour, etc. It is done manually or with the help of grading machines.

8.2.2 Washing

The graded fruits and vegetables are washed with water in different ways, such as soaking and subsequent washing in running water or sprayed with water or dry air to remove surface adhering material. A thorough wash is very essential for improved microbiological quality of final product. Vegetables may preferably be soaked in a dilute solution (0.1%) of potassium permanganate or sodium hypochlorite solution to disinfect them. Agitation of the washing water is effected generally by means of compressed air or a force pump or propeller-type equipment. Among all, spray washing is the most efficient method.

8.2.3 Size reduction

Fruits and vegetables are processed either as whole or into small pieces by size reduction. Size reduction involves peeling, coring and sizing. Peeling is done to remove unwanted or inedible material and to improve the appearance of the final product using a peeler (Fig. 8.1) while coring is done to remove central inedible portion using a corer (Fig. 8.2). There are five main methods of peeling. They are flash peeling (e.g. for root crops), knife peeling (e.g. for citrus fruits), abrasion peeling (e.g. for potato), caustic peeling (e.g. for guava, orange segments) and flame peeling (e.g. onion and garlic). Some of these are given below:

a. Hand peeling

Many of the fruits and vegetables are peeled and cut by hand with the help of special knives.

b. Peeling by heat

Some fruits and vegetables, particularly certain varieties of peaches and potatoes, are scalded in steam or boiling water to soften and loosen the skin, which is subsequently removed easily by hand. It usually involves exposing the fruit or vegetable to a temperature of 40°C for 10-60 seconds where by the skin bursts and retracts facilitating its easy removal by means of pressure sprays. To achieve good results, the fruits and vegetables should be of uniform size and maturity. Using this method, there is practically no loss of flavour and the product is of uniform colour, free from any blemishes.

c. Lye peeling

Fruits and vegetables such as peaches, apricots, sweet orange, carrots, sweet potatoes, etc. are generally peeled by dipping them in boiling caustic soda or lye solution of 1 to 2 percent strength, for short periods, ranging from 0.5 to 2 minutes depending on the maturity of the fruit or vegetable. The hot lye loosens the skin from the flesh underneath. The peel is then removed easily by hand. Any traces of alkali is removed by washing the fruit or vegetable thoroughly in running cold water or preferably by dipping it for a few seconds in a very weak solution of hydrochloric or citric acid.

d. Flame peeling

It is used only for garlic and onion which have a papery outer covering. This is just burnt off.



Fig. 8.1 Fruit peeler



Fig. 8.2 Pineapple corer and its use

8.2.4 Blanching

Blanching refers to the mild heat treatment given to fresh produce such as vegetables to inactivate enzymes. Polyphenol Peroxidase (PPO) is most important groups of enzymes causing browning, off-flavour development in fruits and vegetables. PPO cause oxidation of phenolic compound namely Catechin, Gallic acid, Chlorogenic acid and Caffeic acids. Besides PPO certain peroxidase and pectic enzymes are also require inactivation. Pectic enzymes such as Pectin methyl esterase (PME) and Polygalacturonase (PG) are highly meat resistance and if failed to inactivate may lead to loss of cloud in citrus juices and serum separation in fruits and vegetables products, respectively. Their inactivation is the index of blanching. Blanching also improves colour, flavour and nutritional quality. Usually it is done with boiling water or steam for short periods, followed by cooling. In small scale industries, the fruit or vegetable to be blanched is placed in a wire of perforated basket, which is first dipped in hot water (88-99 °C) for about 2-5 minutes. Microwave treatment is also used for blanching. Blanching requirement varies with different fruit or vegetable and depends upon relative enzyme concentration and maturity of commodity.

8.2.5 Ripening

Ripening before processing may be required for certain fruits such as avocado, banana, kiwifruit, mango, nectarine, papaya, peach, pear, plum, melons, etc. that are picked immature. Ethylene treatment can be used to obtain faster and more uniform ripening. The optimum temperature range for ripening is 15-25 °C and within this range, the higher the temperature the faster the ripening. Relative humidity should be maintained between 90 and 95% during ripening. About 10 ppm ethylene in enclosed chamber is sufficient to initiate ripening. Ethylene is produced by the reaction between calcium carbide with moisture, mainly those involved in trade of fruits to hasten the ripening process. However, indiscriminate application may pose serious health hazards.

Commercially ethephon is used for the pre-harvest ripening of top fruits, soft fruits, tomatoes and coffee. It is also used to facilitate the harvest of fruit and berry crops (by loosening the fruits) and to accelerate post-harvest ripening. It is essentially a plant growth regulator with systemic properties. It penetrates into the tissues and is translocated. It decomposes into ethylene which is the active metabolite.

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