Fruits and Vegetable Products

Hello,, Viewers
Welcome to the lecture series of Food Technology,
In Today's lecture I am going to deliver the lecture on "**Fruits and Vegetable Products**.
This episode divided into the following five sections

1. Introduction
2. General properties of Fruits and Vegetables
3. Chemical compositions in Fruits and Vegetables
4. Fresh fruit and vegetable storage and
5. Conclusion

1. **Introduction**

Fruit and Vegetables are an important source of both digestible and indigestible carbohydrates. The digestible carbohydrates are present largely in the form of sugars and starch while indigestible cellulose provides roughage which is important to normal digestion.

Fruits and vegetables are also important sources of minerals and certain vitamins, especially Citrus fruits, green leafy vegetables and tomatoes are excellent sources of vitamin C and vitamin A. The precursors of vitamin A, including beta-carotene and certain other carotenoids are to be found particularly in the yellow-orange fruits, vegetables and in the green leafy vegetables.

The main objective of fruit and vegetable processing is to supply wholesome, safe, nutritious and acceptable food to consumers throughout the year.

Fruit and vegetable processing projects also aim to replace imported products like squash, yams, tomato sauces, pickles, etc., besides earning foreign exchange by exporting finished or semi-processed products.

The fruit and vegetable processing activities have been set up, or have to be established in developing countries for one or other of the following reasons:

- ≅ diversification of the economy, in order to reduce present dependence on one export commodity;
- ≅ government industrialization policy;
- ≅ reduction of imports and meeting export demands;
- ≅ stimulate agricultural production by obtaining marketable products;
- ≅ generate both rural and urban employment;
- ≅ reduce fruit and vegetable losses;
- ≅ improve farmers' nutrition by allowing them to consume their own processed fruit and vegetables during the off-season;
- ≅ generate new sources of income for farmers
- ≅ develop new value-added products;

2. General properties of Fruits and Vegetables

Fruits and vegetables have many similarities with respect to their compositions, methods of cultivation and harvesting, storage properties and processing. In fact, many vegetables may be considered fruit in the true botanical sense. For example tomatoes, cucumbers, eggplant are classified as fruits on this basis.

However, the important distinction between fruit and vegetables has come to be made on usage basis. Those plant items that are generally eaten with the main course of a meal are considered to be vegetables. Those that are commonly eaten as dessert are considered as fruits. That is the distinction made by the food processor, certain marketing laws and the consuming public.

Fruit as a dessert item, is the mature ovaries of plants with their seeds. The edible portion of most fruit is the fleshy part of the vessel surrounding the seeds. Fruit in general is acidic and sugary. They commonly are grouped into several major divisions, depending principally upon botanical structure, chemical composition and climatic requirements.

Berries are fruit which are generally small and quite fragile.

Grapes are also physically fragile and grow in clusters.

Melons are large and have a tough outer layer.

Drupes ie stone fruit contain single pits and include such items as apricots, cherries, peaches and plums.

Pomes contain many pits, and are represented by apples, quince and pears.

Citrus fruit like oranges, grapefruit and lemons are high in citric acid. **Tropical and subtropical fruits** include bananas, dates, figs, pineapples, mangoes, and others which require warm climates, but exclude the separate group of citrus fruits.

Compositions of vegetables and fruit not only vary for a given kind in according to botanical variety, cultivation practices and weather, but change with the degree of maturity prior to harvest, and the condition of ripeness, which is progressive after harvest and is further influenced by storage conditions.

Most fresh vegetables and fruits are high in water content, low in protein, and low in fat. In these cases water contents will generally be greater than 70% and frequently greater than 85%.

Commonly protein content will not be greater than 3.5% or fat content greater than 0.5 %. Exceptions exist in the case of dates and raisins which are substantially lower in moisture but cannot be considered fresh in the same sense as other fruit.

Legumes such as peas and certain beans are higher in protein; a few vegetables such as sweet corn which are slightly higher in fat.

3. **Chemical compositions in Fruits and Vegetables**

Water

Vegetal cells contain important quantities of water. Water plays a vital role in the evolution and reproduction cycle and in physiological processes. It has effects on the storage period length and on the consumption of tissue reserve substances.

In vegetal cells, water is present in following forms:

- bound water or dilution water which is present in the cell and forms true solutions with mineral or organic substances;
- colloidal bound water which is present in the membrane, cytoplasm and nucleus and acts as a swelling agent for these colloidal structure substances; it is very difficult to remove during drying/dehydration processes;
- Constitution water, directly bound on the chemical component molecules and which is also removed with difficulty.

Vegetables contain generally 90-96% water while for fruit normal water content is between 80 and 90%.

Mineral substances

Mineral substances are present as salts of organic or inorganic acids or as complex organic combinations; chlorophyll, pectin, etc., they are in many cases dissolved in cellular juice.

Vegetables are richer in mineral substances as compared with fruits. The mineral substance content is normally between 0.60 and 1.8% and more than 60 elements are present; the major elements are: K, Na, Ca, Mg, Fe, Mn, Al, P, Cl, S.

Among the vegetables which are especially rich in mineral substances are: spinach, carrots, cabbage and tomatoes.

Mineral rich fruit includes: strawberries, cherries, peaches and rasp-berries. Important quantities of potassium (K) and absence of sodium chloride (NaCl) give a high dietetic value to fruit and to their processed products. Phosphorus is supplied mainly by vegetables.

Vegetables usually contain more calcium than fruit; green beans, cabbage, onions and beans contain more than 0.1% calcium. The calcium/phosphorus ratio is essential for calcium fixation in the human body; this value is considered normal at 0.7 for adults and at 1.0 for children. Some fruit are important for their Ca/P ratio above 1.0: for example in pears, lemons, oranges and some mountain fruits and wild berries.

Even if its content in the human body is very low, iron (Fe) has an important role as a constituent of hemoglobin. Main iron sources are apples and spinach.

Salts from fruit have a basic reaction; for this reason fruit consumption facilitates the neutralization of noxious uric acid reactions and contributes to the acid-basic equilibrium in the blood.

Carbohydrates

Carbohydrates are the main component of fruit and vegetables and represent more than 90% of their dry matter. From energy point of view carbohydrates represent the most valuable of the food components; daily adult intake should contain about 500 g carbohydrates.

Carbohydrates play a major role in biological systems. They are produced by the process of photosynthesis in green plants. They may serve as structural components as in the case of cellulose; they may be stored as energy reserves as in the case of starch in plants; they may function as essential components of nucleic acids as in the case of ribose; and as components of vitamins such as ribose and riboflavin.

Carbohydrates can be oxidized to furnish energy, and glucose in the blood is a ready source of energy for the human body. Fermentation of carbohydrates by yeast and other microorganisms can yield carbon dioxide, alcohol, organic acids and other compounds.

Fats

Generally fruit and vegetables contain very low level of fats, below 0.5%. However, significant quantities are found in nuts (55%), apricot kernel (40%), grapes seeds (16%), apple seeds (20%) and tomato seeds (18%).

Organic acids

Fruit contains natural acids, such as citric acid in oranges and lemons, malic acid of apples, and tartaric acid of grapes. These acids give the fruits tartness and slow down bacterial spoilage.

We deliberately ferment some foods with desirable bacteria to produce acids and this give the food flavor and keeping quality. Examples are fermentation of cabbage to produce lactic acid and fermentation of apple juice to produce first alcohol and then acetic acid to obtain vinegar.

Organic acids influence the colour of foods since many plant pigments are natural pH indicators.

With respect to bacterial spoilage, a most important contribution of organic acids is in lowering a food's pH. Under anaerobic conditions and slightly above a pH of 4.6, Clostridium botulinum can grow and produce lethal toxins. This hazard is absent from foods high in organic acids resulting in a pH of 4.6 and less.

Acidity and sugars are two main elements which determine the taste of fruit. The sugar and acid ratio is very often used in order to give a technological characterization of fruits and of some vegetables.

Nitrogen-containing substances

These substances are found in plants as different combinations: proteins, amino acids, amides, amines, nitrates, etc. Vegetables contain between 1.0 and 5.5 % while in fruit nitrogen-containing substances are less than 1% in most cases.

Among nitrogen containing substances the most important are proteins; they have a colloidal structure and, by heating, their water solution above 50°C, one-way reaction makes them insoluble. This behavior has to be taken into account in heat processing of fruits and vegetables.

From a biological point of view vegetal proteins are less valuable then animal ones because in their composition all essential amino-acids are not present.

Vitamins

Vitamins are defined as organic materials which must be supplied to the human body in small amounts apart from the essential amino-acids or fatty acids.

Vitamins function as enzyme systems which facilitate the metabolism of proteins, carbohydrates and fats but there is growing evidence that their roles in maintaining health may extend yet further.

The vitamins are conveniently divided into two major groups, those that are fat-soluble and those that are water-soluble. Fat-soluble vitamins are A, D, E and K. Their absorption by the body depends upon the normal absorption of fat from the diet. Water-soluble vitamins include vitamin C and several members of the vitamin B complex.

Vitamin A or Retinol

This vitamin is found as such only in animal materials - meat, milk, eggs. Plants contain no vitamin A but contain its precursor, beta-carotene. Man needs either vitamin A or beta-carotene which he can easily convert to vitamin A. Beta-carotene is found in the orange and yellow vegetables as well as the green leafy vegetables, mainly carrots, squash, sweet potatoes, spinach and kale.

A deficiency of vitamin A leads to night blindness, failure of normal bone and teeth development in the young and diseases of epithelial cells and membrane of the nose, throat and eyes which decrease the body's resistance to infection.

Vitamin C

Vitamin C is the anti-scurvy vitamin. Lack of it causes fragile capillary walls, easy bleeding of the gums, loosening of teeth and bone joint diseases. It is necessary for the normal formation of the protein collagen, which is an important constituent of skin and connective tissue. Vitamin C, also known as ascorbic acid, is easily destroyed by oxidation especially at high temperatures and is the vitamin most easily lost during processing, storage and cooking.

Excellent sources of vitamin C are citrus fruits, tomatoes, cabbage and green peppers.

Enzymes

Enzymes are biological catalysts that promote most of the biochemical reactions which occur in vegetable cells.

Some properties of enzymes important in fruit and vegetable technology are the following:

- in living fruit and vegetables enzymes control the reactions associated with ripening;
- after harvest, unless destroyed by heat, chemicals or some other means, enzymes continue the ripening process, in many cases to the point of spoilage - such as soft melons or overripe bananas;
- because enzymes enter into a vast number of biochemical reactions in fruits and vegetable, they may be responsible for changes in flavour, colour, texture and nutritional properties;
- The heating processes in fruit and vegetables manufacturing/processing are designed not only to destroy micro-organisms but also to deactivate enzymes and so improve the fruit and vegetables' storage stability.

In fruit and vegetable storage and processing the most important roles are played by the enzymes classes of hydrolases; lipase, invertase, tannase, chlorophylase, amylase, cellulase and oxidoreductases; peroxidase, tyrosinase, catalase, ascorbinase, polyphenoloxidase.

The Flavonoids; Pigments and color precursors belonging to this class are water-soluble and commonly are present in the juices of fruit and vegetables. The flavonoids include the purple, blue, and red anthocyanins of grapes, berries, plump, eggplant, and cherry; the yellow anthoxa-thins of light colored fruit and vegetables such as apple, onion, potato, and cauliflower. The colorless catechins and leucoanthocyanins are found in apples, grapes, tea, and other plant tissues. These colourless tannin compounds are easily converted to brown pigments upon reaction with metal ions.

4. **Fresh fruit and vegetable storage**

Once fruit is harvested, any natural resistance to the action of spoiling micro-organisms is lost. Changes in enzymatic systems of the fruit also occur on harvest which may also accelerate the activity of spoilage organisms.

To prevent spoilage of fruits must include:

- care to prevent cutting or bruising of the fruit during picking or handling;
- refrigeration to minimise growth of micro-organisms and reduce enzyme activity;
- packaging or storage to control respiration rate and ripening;
- use of preservatives to kill micro-organisms on the fruit.

A principal economic loss occurring during transportation and storage of produce such as fresh fruit is the degradation which occurs between the field and the ultimate destination due to the effect of respiration. Methods to reduce such degradation are as follows:

- refrigerate the produce to reduce the rate of respiration;
- vacuum cooling;
- reduce the oxygen content of the environment in which the produce is kept to a value not above 5% of the atmosphere but above the value at which anaerobic respiration would begin. When the oxygen concentration is reduced within 60 minutes the deterioration is in practice negligible.

Temporary storage

This step should be as short as possible and better completely eliminated. Vegetables can be stored in:

a. simple stores, without artificial cooling;

b. in refrigerated stores; or, in some cases,

Simple stores should be covered, fairly cool, dry and well ventilated but without forced air circulation which can induce significant losses in weight through intensive water evaporation; air relative humidity should be at about 70-80%.

Refrigerated storage is always preferable and in all cases a processing centre needs a cold room for this purpose.

Requirements and functions of food containers

The following are among the more important general requirements and functions of food packaging materials/ containers:

a. they must be non-toxic and compatible with the specific foods;
b. sanitary protection;
c. moisture and fat protection;
d. gas and odour protection;
e. light protection;
f. resistance to impact;
g. transparency;
h. tamper proofness;
i. ease of opening;
j. pouring features;
k. reseal features;
l. ease of disposal;
m. size, shape, weight limitations;
n. appearance, printability;
o. low cost;
p. special features.

Primary and secondary containers

The terms primary and secondary containers have been used. Some foods are provided with efficient primary containers by nature, such as nuts, oranges, eggs and the like. In packaging these, we generally need only a secondary outer box, wrap, or drum to hold units together and give gross protection.

Other foods such as milk, dried eggs and fruit concentrates often will be filled into primary containers such as plastic liners which are then packaged within protective cartons or drums. In this case the secondary container provided by the carton or drum greatly minimises the requirements that must be met by the primary container.

Except in special instances, secondary containers are not designed to be highly impervious to water vapor and other gases, especially at zones of sealing, dependence for this being placed upon the primary container.

Since primary containers by definition are those which come in direct contact with the food, we will be far more concerned with them than with secondary containers.

Hermetic closure

Two conditions of the greatest significance in packaging are hermetic and non-hermetic closure.

The term hermetic means a container which is absolutely impermeable to gases and vapours throughout its entirety, including its seams.

Such a container, as long as it remains intact, will automatically be impervious to bacteria, yeasts, moulds, and dirt from dust and other sources since all of these agents are considerably larger than gas or water vapour molecules.

On the other hand, a container which prevents entry of micro-organisms, in many instances will be non-hermetic. A container that is hermetic not only will protect the product from moisture gain or loss, and from oxygen pickup from the atmosphere, but is essential for strict vacuum and pressure packaging.

The most common hermetic containers are rigid metal cans and glass bottles, although faulty closures can make them non-hermetic. With very rare exceptions flexible packages are not truly hermetic for one or more of the following reasons.

First, the thin flexible films, even when they do not contain minute pinholes, generally are not completely gas and water-vapour impermeable although the rates of gas and water vapour transfer may be exceptionally slow; second, the seals are generally good but imperfect; and third, even where film materials may be gas- and water-vapour-tight, such as certain gages of aluminium foil, flexing of packages and pouches leads to minute pinholes and crease holes.

Films and foils; plastics

Films and foils have different values for moisture and gas permeability, strength, elasticity, inflammability and resistance to insect penetration and many of these characteristics depend upon the film's thickness.

Plastic sheets

- Cellophane paper can be used for packing of dried products, mainly for dried fruit leathers.
- Polyethylene sheets have a variety of uses. They are flexible, transparent and have a perfect resistance to low temperatures and impermeability to water vapour. An important advantage is that these sheets can be easily heat-sealed. Utilization is in forms of sheets and bags. It is a good packing material for primary protection of dehydrated products. If a good protection is needed to prevent flavour and gas losses, it will be necessary to combine polyethylene with other materials.

Laminates

Various flexible materials such as papers, plastic films, and thin metal foils have different properties with respect to water vapour transmission, oxygen permeability, light transmission, burst strength, pin holes and crease hole sensitivity, etc. and so multi-layers or laminates of these materials which combine the best features of each are used.

Laminations of different materials may be formed by various processes including bonding with a wet adhesive, dry bonding of layers with a thermoplastic adhesive, hot melt laminating where one or both layers exhibit thermoplastic properties, and special extrusion techniques.

Glass containers

As far as food packaging is concerned, glass is chemically inert, although the usual problems of corrosion and reactivity of metal closures will of course apply. The principal limitation of glass is its susceptibility to breakage, which may be from internal pressure, impact, or thermal shock, all of which can be greatly minimized by proper matching of the container to its intended use and intelligent handling practices.

Coatings of various types can markedly reduce breakage. These coatings, commonly of special waxes and silicones, lubricate the outside of the glass. As a result, impact breakage is lessened by bottles and jars glancing off one another rather than sustaining direct hits when they are in contact in high speed filling lines.

5. Conclusion

Fruit and Vegetables are an important source of both digestible and indigestible carbohydrates. Fruit and vegetables are also important sources of minerals and certain vitamins, especially vitamins A and C. The systematic harvesting, storage, processing and packaging of fruits and vegetables are very essential to avoid the spoilage and to access throughout the year. Fruit and vegetables have many similarities with respect to their compositions, methods of cultivation and harvesting, storage properties and processing.

Thank you