

## **Modern Food Packaging Technologies: Regulatory Aspects and Global Trends**

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**Lecture – 46**

Welcome to the NPTEL online certification course on Modern Food Packaging Technologies Regulatory Aspects and Global Trends. Dear friends, in the last lecture we have discussed the various factors affecting the shelf life of fruits and vegetables. In the present lecture we will be discussing how does packaging extend the shelf life of fresh fruits and vegetables. What kind of packaging materials should be preferred? Packaging materials for fruits and vegetables, nutrients in fresh produce packaging, which fruits and vegetables should be stored under what conditions. Now let us see how does packaging extends the shelf life of fresh fruits and vegetables.

The packaging slows down the decay process of products. It prevents changes in the color, taste and nutritional value of fruits and vegetables for a long time. The packaging process extends the shelf life of the products. Packaging creates an environment that prevents rotting by controlling the moisture level of the products.

Rot usually occurs when products are left in moist environment. Packaging creates an environment that prevents rotting by lowering the moisture level of the products. Harmful microorganisms may contaminate the products during transportation and storage. Packaging prevents these microorganisms from settling on the products thus prolonging the shelf life of the products. What kind of packaging materials should be preferred? Packaging options for dry or fresh vegetables and fruit packaging materials can be used.

The choice of material may vary depending upon the products characteristics and the storage period. Commonly used packaging materials include paper, cardboard, corrugated cardboard, plastic films, stretch films and various biological materials. Corrugated cardboard is among the widely preferred materials for packaging of fruits and vegetables. Corrugated cardboard is a durable, environmentally friendly and recyclable material. It also prevents products from being damaged and provides air circulation.

Plastic materials are not disposable like corrugated cardboards. They create a suitable environment for microorganisms because they are used many times and the micro cracks on the surface provide a suitable environment. For this reason corrugated cardboard packaging is more hygienic than plastic alternatives. In addition the recycling rate of plastic is lower than corrugated cardboard.

Plastic packaging is not environmentally friendly and leaves residue for a long time when thrown into nature. For these reasons the use of plastic packaging materials has been tried to be reduced in recent years. Corrugated cardboard offers many advantages over plastic materials. It keeps the products fresh, environmentally friendly and recyclable. It also protects during the transportation and storage of products.

Corrugated cardboard costs much less than glass, plastic and wood alternatives. For this reason products made of corrugated cardboard are an ideal option for packaging of fruits and vegetables. The packaging materials for fruits and vegetables. Baskets are made from woven strips of leaves, plastic and bamboo. Bamboo baskets of different shapes and sizes are used for number of perishable commodities.

As the dimensional stability and ability to withstand stacking load is low. They are suitable for head load only and for very short distance transportation only. These packages are not strong enough to withstand rough handling and they are not rigid enough to take the stacking load of more than 2 or 3 baskets. Now, sacks and nets. The materials used for sacks and nets may be woven natural fibres like jute, cotton and woven synthetic fibres like polypropylene, polyethylene, knitted natural fabric like cotton and knitted synthetic fabric like polyethylene or nonwoven synthetic like polypropylene.

The advantage of using sacks and nets are merely financial. The sacks and nets are cheap, have a low weight volume ratio and if made of a synthetic material will not rot. The disadvantages include a low protection against puncturing, compression, vibration and impact injuries such as dropping, difficult stacking and the need of special stitching equipment. In general nets are only suitable for hard produce such as coconuts and root crops like potato and onion. Wooden crates commonly used are wire bound crates for citrus or potatoes, wooden trays for tomatoes and wooden field crates.

The advantages of wooden crates are the crates can be manufactured and repaired locally. Wood is relatively resistant to different weather conditions and water. Wooden crates are often reused and have a higher efficiency for larger fruits for example, watermelons. Most crates have very good ventilation. There are certain disadvantages associated with wooden crates which are untreated wood can easily become contaminated with fungi and bacteria.

Treatment of wooden crates with paint or other chemicals may cause produce deterioration. The material may be too hard or rough for produce like soft fruits and therefore, liners of a soft material may be needed. Manufacturing of wooden crates puts an extra claim on the natural forest resources. A wooden crate consists of rigid corners with planks nailed or is stitched against those corners. For example, the apple or pear crates or field crates.

The solid fiber board boxes. The boxes are used for tomato, cucumber, ginger transport. Most of them are printed with attractive colors, a brand name and a label. The information can be stamped on this label after filling the box. Advantages of solid fiber board boxes.

The low weight and easy handling. The box can have any design although it is recommended to use sizes fitting on the standard design of pallets. The boxes are delivered flat and assembling boxes can be done locally. The box has a low purchase cost. Disadvantages of solid fiber board boxes.

Moisture and high humidity can seriously weaken the box. The low rigidity causes the lower stacking strength compared to wooden or plastic crates. Ventilation holes are usually small because large holes would seriously influence the strength of the box. It is advised that the whole surface area is kept at least 5 percent of the total surface area of the box. The boxes are not reusable.

The corrugated fiber board box. Corrugated fiber board is manufactured in many different styles and weights. Because of its relatively low cost and versatility, it is the popular produced container and will probably remain so in the near future also. The flat surfaces of CFB boxes are known as face and the corrugated surfaces are known as flutes. The strength of corrugated fiber board boxes primarily depends on the GSM that is the gram per meter square of craft paper used and number of flutes per meter and the height of the flutes.

Advantages low weight easily easy to handle cushioning effect due to relatively soft walls. The CFB box can be fabricated to any design. The boxes are delivered flat and assembling of boxes can be done locally. They also have good printability. Above all they are most eco friendly package due to their biodegradability.

The disadvantage associated with CFB boxes are low rigidity and poor stacking strength. High moisture absorbance and low reusability are the major disadvantages are CFB boxes. While packaging of fresh horticultural commodities attention must be given for proper gaseous exchange by providing required ventilation holes. The plastic crates in general plastic crates are more expensive than wooden crates or curtains initially, but in long run they work out to be cheaper because of their more usability and longer life span. Plastic crates are usually made of high density polyethylene or polypropylene.

Advantages of plastic crates as a strong rigid crate these plastic crates can be used for many journeys making the cost per journey relatively low. Different sizes and shapes are available to suit different consumer needs. Colors can be used for marketing purposes.

The containers are easy to clean and disinfect.

Plastic crates are strong and water resistance and therefore, the containers can be used in humid areas and during hydro cooling. Disadvantages of plastic crates are the hard surfaces can damage the produce and it is advised to use liners at the bottom and side. The high purchase cost combined with the risk of the pilferage could make this type of crack a financial risk because this crack can be used several times. The extra cost for the return trip should be included in the total running cost. The loss of space of about 40 to 80 millimeter on the sides and around 10 millimeter from the height is observed.

Shrink wraps one of the newest trends in produced packaging is the shrink wrap of individual produce items. Shrink wrapping has been used successfully to package potatoes, sweet potatoes, apples, onions, sweet corn, cucumbers and a variety of tropical fruits. Shrink wrapping with an engineered plastic wrap can reduce shrinkage, protect the produce from disease, reduce mechanical damage and provide a good surface for stick on labels. Now, the rigid plastic packages, packages with a top and bottom that are heat form one or two pieces of plastic are known as clamshells. Clamshells are gaining in popularity because they are inexpensive, versatile, provide excellent protection to the produce and present a very pleasing consumer package.

Clamshells are most often used with consumer packs of high value produce like a small fruits, berries, mushrooms etc are items that are easily damaged by crushing. Plastic net bags extruded and woven, the plastic net bags have the feature to stretch and accommodate all sizes and shapes of produce. These bags are available in roll form or in pre cut lengths with stretch width of 200 to 400 millimeters. By allowing air to circulate in and around the produce, these net bags prolong the freshness and shelf life of the produce. They also eliminate pack condensation thereby preventing spoilage and wastage.

They make a colorful point of sale display by allowing clear visibility of the contents, enhancing the natural colors of fresh produce. These are generally made up of HDPE and polyamides. New trends in fresh produced packaging, the jute reinforced plastics, jute fibers and wood are combined with thermoplastic materials like LDPE and HDPE for making semi rigid as well as rigid boards. The film layer is placed on both sides of the nonwoven jute. The composite layers are pressed in a hydraulic press at the required temperature for a certain period of time depending upon the thickness of the end product and the type of the film used.

These boards have good tensile strength, puncture resistance and moisture barrier property. JRPs are now being increasingly used for transport packaging of horticultural products. The modified atmosphere packaging fresh fruits and vegetables are leaving

organisms having high level of respiration and other metabolic processes associated with maturation, ripening and senescence. The MAP system is a dynamic one where respiration and permeation occur simultaneously. Factors affecting both of these must be considered when designing a package.

The respiration in a package is influenced by many factors like quantity of produce, stage of maturity, temperature of storage, concentration of ethylene gas and light intensity. The permeation of the package is influenced by following factors like type and nature of materials, thickness and surface area of the material, temperature and relative humidity, partial pressure gradients of oxygen and carbon dioxide. All the above factors interact to create equilibrium levels of oxygen and carbon dioxide inside the sealed package. The selection of a film or a combination of more than one film that is laminate depends on the expected transportation and respiration rates of the produce. For most of the fresh produce film selected be more permeable to carbon dioxide than to oxygen.

Most of the commercially available films are as indicated in next table. This table represents the various films which are used in the packaging of fruits and vegetables and having the properties like water vapour transmission rate and the gas transmission rates of oxygen, carbon dioxide and nitrogen. For example, the polyethylene that is the low density polyethylene has got the water transmission rate of 18 and oxygen transmission rate is 7800 and carbon dioxide transmission rate is 4200 and nitrogen transmission rate is 2800. So, depending upon the need one can select either one or in combination for the laminate for the packaging of selected fruits and vegetables. Some of the characteristics of plastic films for map of fresh produce are required permeability for different gases which have just now discussed in the last table.

Good transparency and gloss, high tear strength and elongation, good thermal and ozone resistance, commercial suitability, ease of handling. The advantages of map for a few fruits and vegetables based on the R and D work carried out at Central Food Technological Research Institute, Mysore, India are given in next table. The shelf life of different fruits and vegetables under map are different for the different fruits and vegetables at room temperature and a particular storage temperature or reduced temperature and at low temperatures with oxygen and carbon dioxide percentage is given like for bananas if it is stored at room temperature then the shelf life is around 11 days when it is stored in map with an oxygen percentage of 12 to 15 percent and carbon dioxide up to 7 percent and if it is not stored in these concentration means that is the F then its storage life is only 6 days. Like if the temperature is 13 degree Celsius means slightly low then the shelf life is increased at 248, 42 days with the oxygen transmission rate at 7.

9 to 16 percent and carbon dioxide level is 4.727. The different fruit crops they have

studied and presented in this table. Recommended controlled atmospheric conditions during transport and storage of vegetables is also presented in this table like the storage temperature during the transportation what should be the storage temperature, what should be the optimum oxygen level in the controlled atmospheric condition and what should be the optimum level of carbon dioxide then what is the expected shelf life of that. So one can choose and they can revise a packaging for transportation under the controlled atmosphere temperature from this table. So for different vegetables it is given active packaging.

Another way of modifying the atmosphere pack is by using active packaging. Packaging is termed as active when it performs some desired role other than to provide an inert barrier to the external environment. The goal of developing such packaging is to create a more ideal match of the properties of the package to the requirements of the food. Active packaging can be created by using oxygen scavengers, carbon dioxide absorbents or emitters, ethanol emitters and ethylene absorbents. The appropriate absorbent material is placed alongside the fresh produce.

It modifies the head space in the package and thereby contributes to the extension of shelf life of the fresh produce. Active packaging principles applied to the perishables are presented in the following table. The principle based on the principle like porosity control and the application of this is gas pressure release, gas composition balance like polymer permeability control, gas compensation balance, temperature compensation balance etc. Which fruits and vegetables should be stored under what conditions? Generally low temperatures and high humidity are required to store fruits and vegetables. Therefore cold storage is used for the storage of these products.

The packaging used during storing and transporting fruits and vegetables is essential to prevent the products from rotting and being damaged. Fresh fruit and vegetable packaging prevents the products from being damaged ensures air circulation and keeps the products fresh for longer. Dried fruits can be stored at room temperature. However factors such as humidity and temperature can affect the quality of the dried fruits. Therefore dried fruits should also be stored with proper packaging.

Dry fruit packaging prevents the products from being affected by moisture and keep them fresh. The packaging process of fresh fruits and vegetables is critical to preserve the flavor and nutritional value of the products. Therefore wholesalers should protect their products by using suitable packaging materials. Another critical factor in fruits and vegetables packaging is the foil, is the foil technology.

Some sensitive fruits may be damaged during transport. They should not come into

contact with each other. Sensitive fruits rot quickly and lose their nutritional value when they come into contact with each other. Voils which consist of recesses prepared by the products structure prevent the products from contacting each other. Products stay fresh from field to table. Thank you very much.