Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Week – 10
Lecture – 50

Welcome to the NPTEL online certification course on modern food packaging technologies, regulatory aspects and global trends. Dear friends, in the last lecture we were packaging the confectionery items. In the present lecture we will see the packaging of different types of beverages and This lecture will include the introduction, product characteristics and packaging materials for non-alcoholic beverages, non-carbonated drinks, carbonated drinks, then product characteristics and packaging materials for alcoholic beverages which will include non distilled alcoholic beverages and distilled alcoholic beverages. Introduction The beverage industry is one among the front liners where massive investments are being made for expansion and technological upgradation. The packaging of beverages both carbonated and non-carbonated is a complex technological branch in the food processing and packaging industry.

The traditional returnable glass bottle has given way to newer plastic containers as well as cartons. The current trend is to improve the conventional containers, extend their share in the large market, extend the shelf life of the products, provide greater consumer convenience and ultimately to produce economics packages. The changing Indian scenario with implementation of various technologies and market promotion activities has changed the scope for this industry exponentially. The term beverage is derived from French word beivre which means a drink.

General meaning of a drink includes a prepared drink. According to the fruit product order that is FPO 1 1955 act, fruit beverage or fruit drinks means a beverage or drink which is prepared from fruit juice and water or carbonated water and containing sugar, dextrose, inward sugar or liquid glucose. The minimum percentage of fruit juice in the final product shall not be less than 5 percent. Fruit syrup cannot sweeten fruit juice is not less than 25 percent of fruit juice. The classification of beverage, the beverages are mainly classified into two groups that is non-alcoholic and alcoholic.

The non-alcoholic are further divided to again two groups that is non-carbonated and carbonated. The non-carbonated drinks include fruit juices, fruit drinks, fruit nectars, coffee, tea etc whereas, the carbonated drinks that include soda, coca cola, tonic water etcetera. The alcoholic drinks are again further divided into two groups that is the fruit sap prepared from the fruit sap and prepared from the grain. Again fruit sap is further

divided into two groups which is non distilled and distilled. The non distilled the example of this is wine and distilled the example of this is brandy.

In the grain also there are two groups non distilled and distilled. The non distilled for example, beer and distilled for example, different types of hiskis. The packaging requirements for all types of beverages are the absolutely leak proof and prevent contamination. It should protect the contents against chemical deterioration. It should not pick up any external flavors.

It should be hygienic and safe. It must retain the carbonation in the case of carbonated beverages. At the same time it should be economical and easy to use as well as dispose and at the last it should be good aesthetic appearance. Now, the product characteristics and packaging materials for non alcoholic beverages. The fruit beverages these include fruit juices, fruit drinks and fruit nectars.

They contain fruit juice, water, sugar, dextrose, inward sugar etc. The major deterioration that occurs in fruit beverage is loss of nutrition, physicochemical changes and microbial growth. The product characteristics to be considered in relation to packaging are the acidity. All the fruit juices usually maintain an acidity character because they contain organic acids. Enzymes exist in all fruit juices.

Sometimes they have to be destroyed and sometimes they have to be added. Vitamin C or the ascorbic acid. The vitamin C content of a fruit increases until just before ripening and then decreases due to the action of an enzyme ascorbic acid oxidase. When fruits are cooked most of the ascorbic acid transfers from the tissue into the liquid or may be oxidized. Oxidation occurring more easily in iron, copper or badly tinned vessels.

Losses of vitamin C also occur during storage. Storing at low temperature and preventing contact with air and light reduces this. Addition of sulphite has a preserving effect on vitamin C. Colour and flavour. They are very important and many fruit drinks contain certain legally permitted colourings.

These are added to overcome the bleaching effect of the sulphite used as a preservative and to provide an attractive appearance. Spoilage of fruit juices is mainly due to yeast. Its growth depends upon the temperature. Spoilage of raw fruit juice at room temperature results in alcoholic fermentation followed by the oxidation of alcohol and fruit acids by yeast or moulds growing on the surface. Hence every living yeast cell must be removed or suppressed by pasteurization, filtration and are preservatives.

The key parameters to be considered when selecting a packaging system are the first one

is the process, which process is going to be adopted, then the distribution, shelf life requirements and legislation, the product composition and quality as produced and at full shelf life. The product protection required during storage, distribution and retail sale. Pack size, printing options and display etc. Packing system concept, automation options, ability to integrate with existing and or future systems. Consumer appeal, image of product and packaging.

The different packaging materials used are glass containers. The use of glass bottles for the packaging of fruit beverages was widespread although the hot fill hold cool process had to be applied with care to avoid breakage of the containers. Glass is still the preferred packaging medium for high quality food beverages. However, over recent years an increasing proportion is being packed aseptically into curtains. The improvements that have occurred in glass bottle packaging are light weight, surface coating to increase abrasion resistance and use of wide mouth containers fitted with easy open caps.

The next one is metal containers. The tin plate can made of low carbon mild steel of 99.75 percent purity coated with tin with easy open ends are used. These tin plate containers are either three piece or two piece containers. They are lacquered internally to prevent corrosion.

The plastic containers, fruit juices contain organic substances which are sensitive to bacterial contamination. The packaging of such products is done through hot filling to achieve extended shelf life. Pet bottles are usually used for hot filling applications. Special features are added to the containers through design and manufacturing process. The package is heat set in order to improve the temperature resistance of the containers.

The pet resins with a higher glass transition temperature and are faster rate of crystallization are used. Normally hot filled pet bottles are designed about 1.5 times heavier than cold filled bottles. Reinforcing rips and grooves are also provided along the circumference and base of the bottle. After filling and capping operations, the liquid continues to cool which results in formation of vacuum.

The bottle wall can be deformed under the influence of vacuum and this problem is overcome by providing vacuum panels in the container side wall. Generally, lower levels of pet copolymer are preferred and intrinsic viscosities of about 80 are acceptable. Flexible plastic packages offer economic savings over conventional glass and metal containers, but they are permeable to oxygen. Therefore, it is critical to select a flexible package that minimizes the permeability to oxygen. Flexible laminated pouches like metallized polyester, polyethylene are used for hot filled packaging method without

retorting for acidic fruit juices.

These are used either as flat pouches or stand up pouches. However, the shelf life of the product in these pouches is limited. Generally the aseptic packages ready to serve fruit beverages and fruit pulps concentrates packed in aseptic packages provided excellent protection for fruit juice and pulps. These aseptic packages are made by combining thermoplastic with paper board and aluminum foil. Their multi layered construction enables the cotton to protect the contents from various factors responsible for spoilage.

The aluminum foil layer is a strong barrier for oxygen and light. The inner plastic layer made of polyethylene makes it possible to seal through the liquid. The outer paper layer provides stiffness making it possible for the cartons in a brick shape thus enabling maximum utilization of available storage and transportation space. To provide convenient access to the content beverage cartons offer a variety of opening devices a familiar opening feature of the pack is the drinking straw which is attached to the package. Some recent trends are pool tab opening which can be readily detached from a pre punched hole without compromising the package integrity.

Custom designed caps and closures can be incorporated on beverage cartons for easier pouring and for enhancing the brand image. Also the beverage cartons are now available in prism shape which is comfortable to hold and the unique shape offers maximum display effectiveness and high space efficiency. These packs are shelf stable at room temperature and the shelf life and nutrient composition of the fruit juice is influenced by the barrier properties of the tetra pack. Now the bag in box system it consists of a collapsible bag within a rigid container a filling machine to introduce the liquid product into the bag and a dispenser to draw the product out. The bag the outer container can be a box a crate or a drum the bag actually consists of two bags and inner bag contains the liquid and the outer bag provides the barrier properties.

Both are heat sealed at the edges the tubular spout fitted to the bag aids in filling and dispensing of the product as little as 3 liters or as much as 1000 liters can be packed. The bag is the life of the system the bag itself consists of three components one is inner layer the outer layer and the spout. The function of the inner layer the one in contact with the material being packed is to provide the bag with seal integrity. The seals are to be strong enough to withstand constant mechanical and chemical pressure for at least twice the expected shelf life of the product. Generally the inner layer is not designed for barrier unless the product needs extra barrier which the outer layer cannot provide.

The plastic films manufactured from high performance polyethylene with excellent sealing and puncture properties are usually used as inner layer materials. The spout and

cap assembly are made of injection molded plastics. The spout is provided with a flange which is welded to the bags inner layer during bags manufacture. The spout and cap have two functions they are used to fill the product in the bag and are also used to dispense the product from the pack. Several spout types are available ranging from a simple bung like configuration to ones which can only be opened on the filling machine.

The caps come with various tamper evident features as well. The coffee, coffee is made from the coffee beans which is converted into consumable beverage. Some of the major deterioration reactions in coffee are the staling. This may be due to the loss of flavor volatiles or due to chemical changes caused by moisture and oxygen absorption. Evolution of carbon dioxide which is emitted during the roasting process.

Ingress of moisture in instant coffee results in caking. This usually happens when the moisture content reaches 7 to 8 percent. The initial moisture content of instant coffee is only 2 to 4 percent. Hence while developing packaging system for coffee the following are to be considered. Moisture vapor ingress, oxygen permeability, carbon dioxide and volatile component ingress, grease resistance.

The packaging materials used are tin plate containers, composite containers, glass jars and flexible plastic pouches. The flexible laminates most widely used are 12 micron PET, 2 micron aluminum foil, 17 micron LDPE and metalized PET and LDPE laminates. Aluminium foil lined plastic pouches are most popular having 59 percent contribution in terms of volume. Now, the tea. The unique taste and color of tea is because of polyphenols that is catechins and amino acids that is thiamine.

The flavor is due to the essential oils present in fresh leaves and volatile components developed during the manufacturing process. The different types of tea are black tea that is fermented tea, oolong tea that is semi processed tea and green tea that is non fermented tea. Deterioration is caused by loss of volatile components increase in undesirable taints arising from oxidation reaction from fatty acids. Deterioration in green tea is caused by reduction in ascorbic acid content, changes in color from bright green to olive green and changes in odor. The most common packaging material is paper board cartons with a liner or an overlap of PP or a regenerated cellulosic films.

The other types are plastic jars bottles pouches strips and envelopes plastic pouches have captured 12 percent of the tea market. Now, the carbonated drinks. The carbonated drinks contain carbonated water, flavor, color, sweeteners and preservatives. Carbon dioxide gas from pure source is dissolved in water, amount varies with different types of beverages. A variety of ingredients like flavoring agents, coloring agents, preservatives, artificial sweeteners, antioxidants and foaming agents are then added.

Two major deteriorative changes that occur in carbonated drinks are the loss of carbonation and rancidification of essential flavoring oils. The first is largely a function of the effectiveness of the package in providing a barrier to gas permeation. While the latter can be prevented by the use of high quality flavorings and antioxidants and deaerating the mix prior to carbonation. Oxidative rancidity is reduced by effectiveness of the package in providing a barrier to gas permeation. Hence, the carbonated drink package requires a container that will hold pressure and not contribute off flavor.

For many years virtually all carbonated soft drinks are packaged in glass bottles sealed with crown cork. In recent years non-returnable glass bottles are giving way to refillable bottles. These have a form plastic protective label of paper, poly or an all plastic shrink sleeve as a safety measure to prevent flying of glass fragments in case of breakage of these containers. The crown closure has been replaced with a roll on aluminum screw cap with tamper proof facility. Among the metal containers the three piece can have been used since long for the packaging of carbonated beverages.

These are being now replaced by two piece aluminum cans. These cans retain the integrity of lacquer better than tin cans. Vinyl epoxy and vinyl organosol coatings are used at lacquers for aluminum cans. Epoxy amine provides good adhesion, color and flexibility to the can. Among the plastic containers PET bottles are the most preferred packaging material for packaging of soft drinks.

The polyethylene terephthalate bottles satisfies most of the requirements for packaging of carbonated soft drinks. Improved blow molding techniques and biaxial stretching have made PET containers to be pressurized due to its strength, dimensional stability and precision. Also they have a glass like appearance, good transparency, luster, chemical inertness and unbreakability. The advantage of PET containers are superior packaging to product ratio. PET containers being 63 percent and 47 percent more energy efficient than glass bottles and aluminum cans respectively.

PET bottles are 32 percent more energy efficient than glass bottles during delivery of 1000 gallons of soft drinks. Glass bottles and aluminum cans generate 230 percent and 175 percent times more atmospheric emissions compared to PET. PET bottles contribute 68 percent and 18 percent less solid waste by weight compared to glass and aluminum containers. 100 kg of oil is required to produce 1000 1 liter PET bottles as against 230 kg for 1000 equivalent glass bottles. PET bottles help in fuel saving due to their lower weight.

The resins used in PET bottles to pack carbonated drinks are of a very special quality.

The PET bottles have to be extremely strong to contain the internal pressure of carbon dioxide without distortion and expansion. This is obtained by using a resin which has high intrinsic viscosity and lower copolymer levels. Now, the product characteristics and packaging materials for alcoholic beverages. Alcoholic drinks originated through the action of yeast cells on sugar containing liquid.

Alcoholic drinks are aromatic liquids with a specific alcohol content. Some kinds contain carbon dioxide, others a quantity of sugar. They are either fruit sap based or grain based. They can either be non distilled or distilled depending on the volume percentage of alcohol per liter. The border between the two kinds of drink is about 20 percent.

The different types of alcoholic beverages are beer, wine, whisky, brandy etc. Non distilled alcoholic beverages like beer, grain based. Beer is made from grains and has low alcohol content around 5 percent by volume. Barley is the chief grain, but rice and corn are also used. The grains are brewed and fermented and then carbonated with carbon dioxide and flavored with hops to give a bitter flavor.

Owing to its low pH about 4, microbial degradation is not usually a problem with beer and the use of pasteurization and aseptic cold filtration excludes yeast. However, during storage beer can undergo irreversible changes leading to appearance of haze, development of off flavor and increased color. The oxidation reaction gives beer a cardboard like flavor. Flavor loss is also accelerated in the presence of light and certain metal ions. The fermentation process consumes oxygen also brewing reduces the level of oxygen in beer to about 40 to 50 parts per billion prior to packaging.

During the packaging process atmospheric oxygen enters the package and the level of oxygen concentration reaches 250 to 500 ppb which corresponds to 0.1 to 0.2 ml of oxygen per 335 ml bottle or can. This results in shelf life of beer of 80 to 120 days. The oxygen consumption of beer varies with the consumption of the beer.

Its age, presence of reducing agents, temperature etc. The traditional packaging media for beer is the glass bottle sealed with a crown closure. Recent development is the use of PET bottles for packaging of beer. Types of PET beer bottles used are non tunnel pasteurized, one way tunnel pasteurized and returnable refillable bottles. Improvments in the barrier can be obtained via colorants creating multilayer bottles and scavengers. Protection from UV light is obtained by adding colorants or UV additives during the injection molding stage.

Because of the varied requirements for beer the resin chosen must provide an adequate

barrier UV protection and clarity. Beer bottles need strength in order to maintain the carbon dioxide pressure over a wide range of temperature. Intrinsic viscosities, intrinsic viscosities in the range of 80.

8 to 0.84 are normally used. Since, the PET bottles are lighter a truck can carry 60 percent more of the beverage and 80 percent less packaging a fuel saving of 40 percent and less air pollution. Now, the wine fruits sap based. The wine is a beverage resulting from the fermentation of yeast, resulting from fermentation by yeast of the juice of grapes with appropriate processing and addition. The major deteriorative reaction in wines is caused by oxidation. The oxygen gradually changing the wine character leading to development of browning and undesirable flavors.

The most common form of packaging used for wines is the glass bottle sealed with natural cork. Since wines are affected by sunlight the bottles usually used are of colored glass. Bottle wine is normally stored in horizontal position so that cork is kept moist thereby providing a better barrier to the ingress of oxygen. The most significant change in the packaging of wine resulted from the development of the bag in box package. A flexible collapsible fully sealed bag made from one or more piles of synthetic films.

A closure and a tubular spout through which the contents are filled and dispensed and a rigid outer box or container. The bag is generally constructed from co-extruded films of EBA, BA, EVOH, BA, EVA or LDPE, BA, EVOH, BA, LDPE. The features of the bag in box system of packaging have been explained earlier in this lecture. The distilled alcoholic beverages, brandy and whisky these drinks are obtained by distillation of alcohol containing drinks.

During distillation the aqueous parts is separated from the alcohol. The distillates obtained are sold under several names like brandy, gin, whisky, cognac, vodka etc and have different alcohol percentage. Because of their high alcohol percentage these liquors are mostly packed in glass bottles so that they can be kept for an indefinite time after opening. The bottles are sealed to prevent alcohol from evaporating and to protect the contents of the bottles from dirt and dust. Thank you very much.