Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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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 seen the packaging of Bakery and RTE foods. In the present lecture we will be covering confectionery food items and we will be covering introduction, product characteristics and packaging requirements, criteria for selecting packaging materials, packaging materials used for confectionery items. Introduction the confectionery items are commonly consumed by the populace and generally used for taste and desire and becoming very popular especially amongst children and youth. There are various types of confectionery items available in market that is cakes, pastries, donuts, candies, wafers, chips, chewing gum and chocolates. There are some leading industries in the field of confectionery products are Cadbury, Nestle, Perfetti, Riglet, Parlay and Amul etc.

The organized market for sugar confectionery is estimated to be 1 like 39000 tons per annum and is growing at the rate of 10 to 15 percent per annum. The confectionery market has undergone a metamorphosis in the last few years. A package intended for sugar and chocolate confectionery has to perform several functions during distribution, storage and sales. Essentially the package has to preserve the quality attributes of the product and afford protection against chemical and microbiological deteriorative reactions.

If we see the global statistics the market value in 2023 was 11.68 billion US dollars whereas, it is estimated that 2032 it will reach to 18.28 billion US dollars with the CAGR rate from 24 to 32 at the rate of 5.1 percent. In which the chocolate packaging segment market value in 2023 is alone 5.17 billion and in the North America it is more than 4 billion US dollars. For sugar confectionery items and chocolates the major functional packaging requirements include protection from dust, dirt and other contaminating agents, moisture and water vapor pickup or loss resulting in sugar or fat bloom, stickiness, hardening and desiccation. The third one is rancidity due to interaction with moisture and oxygen. The color and aroma loss and tenting and the loss is physical damage like dusting, breakage and loss of shape. The product characteristics and packaging requirements confectionery is hygroscopic in nature and requires protection against the ingress of moisture and exposure to high temperature as far as possible.

A candy or confectionery product may be adversely affected by many things. Hard candy,

brittle and crunch products are most sensitive to moisture and absorb water vapor fairly rapidly from the atmosphere. Various gums are less sensitive while some creams tend to lose moisture considerably. The factors that lead to spoilage of confectionery are highlighted in the further slides. The first one is crystallization.

The sugar component of most types of confection is in a soluble form and it is essential that this form be maintained. Since the crystallization of the sugar alters the taste and texture giving impression of an old product. Moisture interchanges play a major decisive role in deciding the shelf life of confectionery items. The equilibrium relative humidity of a confection during its life determines its sensitivity towards all physicochemical changes that occur due to environmental conditions. Data on moisture absorption characteristics of a confectionery item are very important in understanding the storage stability as regards its chemical and physical changes, growth of microorganisms and also drying characteristics and product formulation and package selection.

This table represents the different types of deterioration which is caused in different types of confectionery items with respect to its equilibrium relative humidity. Like for example, boiled sweets and toffee the main deteriorative causes is graining and stickiness and the equilibrium relative humidity is less than 30 and less than 50 respectively. Like for example, gums and pasteles, licorice, paste foods, turkish delight the main deterioration factor is stickiness, microorganisms growth and its ERH varies from 55 to 70 percent. Likewise for different fruit confectionery items it is given in the table with their equilibrium relative humidity. The second one is water activity.

The end of shelf life due to moisture loss or gain with subsequent changes in textural and other properties is often the main problem in confections. Thus an understanding of water activity is more important for control of shelf life and stability. Water activity in confections generally falls below the critical values for microbial growth with few exceptions. Water activity is influenced by the presence of dissolved sugars, other sweeteners for example, polyols, salts for example, caramel and humectants in confections. Microbial growth is directly related to water activity with certain types of microbes unable to grow when water activity is below some critical value.

Microbial growth also decreases with reduction in water activity. Majority of bacteria and many yeast stop growing below water activity of 0.88. Only few osmophilic yeast and molds grow below water activity of 0.7 and no microorganisms can grow below the water activity of 0.

6. This graph shows the relation between water activity and the relative reaction rate as well as the moisture content. If we see that when the moisture content increases the water

activity increases and similarly the relative reaction rate that decreases to a certain level that is up to 0.35 or so, but after that then water activity increases the reaction rate increases. The range of water content and water activity in confections like hard candy the crystallinity is 0 to 2 and moisture content varies from 2 to 5 percent weight basis and the water activity is 0.25 to 0.4. Likewise for different confectionery products it is given which is presented in the table 2. The criteria for selecting packaging material. In selection of packaging materials for confectionery the following need to be considered. The first is water vapour transmission rate. The knowledge of WVTR of packaging materials and the effect of folding, creasing, crumbling of materials on papers and aluminium foil show considerable effect.

However, thermoplastic materials are not much affected. The next table gives the effect of folding, crumbling on WVTRs of some thermoplastics. Like for metalized pet of 12 micron when it is in the flat form is WVTR is 0.9 when it is in folded form it is 1.7 when it is in the crumpled form it is 3.

4 and when it is gel bow flex form it is 18. Like for other materials also it is given that WVTR which varies according to their shape and size. Gas transmission rate. The permeability of gases like oxygen decides the shelf life of oxygen sensitive confectionery items. The oxygen transmission rates of some plastic materials and the effect of folding and crumbling is shown in following table.

Likewise like previous table it shows the different forms on the oxygen transmission rate of different plastic materials. Like metalized pet of 12 micron the flat form the oxygen transmission rate is less than 1 whereas, in folded form it is 5.5 in crumpled form 16 and gel bow flex form 59. The grease resistance. The grease resistance of the packaging material is important to avoid seepage of oils and fats and smudging of the print.

Next is tensile strength and elongation. Tensile strength and elongation properties of materials need to be studied as their running on high speed machines should be suitable. Tear strength. For a confectionery film tear strength is of importance as low tear values are necessary and useful for opening packages by hands.

Heat seal strength. The performance of a finished package is determined by the effectiveness of the package seal that is the permeabilities to water vapour gases and volatilize increase if the seal is not perfect. Thermo plastic films such as polyethylene give excellent heat seals. The performance properties apart from the above mentioned important properties a material has to perform well on machines. Therefore knowledge of physical properties like slip stiffness blocking resistance is also necessary. Twist retention for twist trap is also of importance.

Packaging materials used for confectionery items. A very high quantum of polymeric materials besides cellulosics and aluminum foil are used for confectionery items. Paper board and metal containers are also used for certain applications. Although a variety of packaging materials are available the ultimate choice of the wrapper depends upon the required shelf life, performance on the rapping machine and the cost which is purely based on the segment of the market targeted by the manufacturer. The most common choice of packaging medium is plastic generally flexible as it provides the required protection and preservation.

Grease against grease resistance physical strength machine ability and printability. Plastics being lighter in weight are therefore, the most preferred material for packaging of confectionery. Depending on the type of package that is twist trap, pillow pack and vertical flow pack or roll pack the plastic based packaging films used for confectionery are mentioned in the subsequent slides. The first one is polyethylene. It is considered to be the backbone of packaging film.

Since one of the greatest threats to the integrity of confectionery products comes from moisture polyethylene with its low water vapor transmission is of definite interest. Polyethylene films are fairly free of plasticizers and other additives and are quite extensively used as a part of lamination. Its ability to heat seal increases its value. The next one is polypropylene. Polypropylene films are undergoing a growth trend in the confectionery industry.

They have better clarity than polyethylene and enjoy superior machinability due to its stiffness. Lack of good seal ability has been a problem. However, PVDC and vinyl coating have been used to overcome this problem. Some varieties of polypropylene have been specially developed for twist trap applications as they have the ability to lock in position after twisting.

Polyvinyl chloride. The PVC is a stiff and clear film having low gas transmission rate. PVC can be used as small wraps, bags and pouches. PVC when copolymerized with polyvinyl with polyvinylidene chloride is known as sarin. Once it is a costly material, it is only used as a coating to obtain barrier properties and heat sealability. PVC film is also used for twist wraps as it has twist retention properties and is excellent on high speed machines.

The polyesters and polyamide. Polyethylene terephthalate film has high tensile strength, gloss and stiffness as well as puncture resistance. It has moderate WVTR, but is a good barrier to volatiles and gases. To provide heat seal property PET is normally laminated to

other substrates. Nylons or polyamides are similar to PET, but have high WVTR.

Metalized films. When polymeric films are metalized, there is an improvement in their barrier properties. Metalization is also used for decorative purposes and aesthetics. The films which are used for metalization are PVC, PET, PP and polyamides. Semi-rigid containers. These comprise folding cartons, set of boxes, line folding cartons and thermoform containers.

Collapsible folding cartons of tray type with coated or laminated paper board, paper board base are extensively used to package dairy food based sugar confections. These cartons with outer embellishments are best suited for gift and display applications. The liner material may be PE, wax, EVA, blends or PVC or PET films. Set of boxes of either half or full telescopic type having inner glassine liner are economical and provide good physical and mechanical protection. Lined folding carton system is of bag in box type where an inner pouch is lined or fixed to the outer paper board carton.

The selection of the material of the pouch is decided by the functions required economics and marketing requirements. Materials such as paper PE, PET PE, paper aluminium foil PE and the almost ultimate choice is PET aluminium foil PE are used. Provisions for reclosing, reduction of head space volume and such features can be incorporated. Thermoform containers include blister packs, single and multiple cavity trays, thin walled containers with leads etc. These are produced by the process of thermoforming by vacuum pressure or matched mold forming techniques.

For packing sweets thermoform tray type containers are better suited. For multi coating trays the number, shape and size of cavities is determined by the product to be packed. Such trays are useful when a number of similar or assorted items are packed. Now, the eco friendly packages bio containers are eco friendly packages based on natural materials such as leaves of banana can also be used to contain and distribute sugar based confectionaries. The processes developed by CFTRI that is Central Food Technological Research Institute of India to manufacture these involve only heat treatment without recourse to any antimicrobial adhesive or chemical treatments.

The rigid packaging systems among the metal containers the conventional tin plate are being used to process rasagolla and gulab jamun in syrup. Tin plate cans are available in various standard sizes for flat sweets 100 gram cans are preferred. For gas flushing applications formed cans with aluminum top cans are used. Newer metal containers include differentially coated cans, chromium coated that is tin free steel cans. The provision of ring pull ends that is easy open end facilitates easy opening of consumers. Now, the composite containers these are made of paper board body and metal or plastic

ends. The container body may either be spirally or convolutedly wound with fire board lined with aluminum foil. Composite can having a body material of 25 nanometer PE, paper board 0.009 nanometer aluminum foil and then 37 nanometer LDPE. The composite can having a body material of 25 millimeter PE, paper board then 0.

009 millimeter aluminum foil followed by 37 millimeter LDPE are well suited to package sweet mats. Thank you very much.