Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

Prof Prem Prakash Srivastav
Department of Agricultural and Food Engineering
Indian Institute of Technology Kharagpur

Week – 11
Lecture – 54

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 recent trends in packaging materials with a special reference to biodegradable and compostable materials. Now in the present lecture we will seeing the edible packaging materials and this will cover the introduction what is edible packaging, edible packaging options, materials for edible packaging, development of edible packaging, applications of nanotechnology in edible packaging, advantages of edible food packaging and challenges and limitations of edible packages solutions. The introduction It is amazing that food preservation has no time barrier knowing how to preserve food has been essential throughout our history as human beings. It helped us survive by not only extending our foods self life, but also by enabling the preservation of healthy food. Today thousands of year later food packaging is just as essential as it was, if not more consumers demand have increased causing the market to enlarge its products.

As plastic packaging has crept gradually into our lives replacing metal, paper and glass containers critics about it have risen calling out its harmfulness to environment. Even though recycling plants are established globally only 14 percent of the plastics is recycled. Plastics has been a main stay in the food industry for decades and concerns about its environmental harm have reached global levels. As we learn more about the importance of sustainability and the various initiatives taken to reduce our dependence on plastics, we must consider the many alternative options and innovations becoming increasingly available as technology and advancement.

For that reason the current trend in food packaging development is that wherever possible it should not only be natural and environmentally friendly, but also functional and cost effective. One such alternative worth considering is edible packaging which has recently gained traction in recent years due to the clear paradigm shift towards eco friendliness.

Governments, businesses and packaging experts are already beginning to invest more money into this alternative resulting in a quickly expanding market ready to be tapped. What is edible packaging? As the name suggests it is a type of sustainable food packaging design to be eaten or biodegradable as efficiently as the food it protects. Commonly made from natural plant based materials such as seaweeds or casein any type of film sheet layer or coating qualifies as edible packaging so long as it can be eaten alongside the food product.

And with the package being consumed instead of disposed of this sustainable packaging method is perfect for helping reduce our dependency on plastics while naturally generating less waste as everything is eaten leaving nothing behind. Thankfully consumable food packaging is available in various types bio materials and plant by products making it a solid choice to swap traditional packaging for an eco friendlier option. So now that when it is known what edible packaging is and its role in reducing waste in the food industry one may wonder what types are available. The edible packaging options: The straws, Consumable straws such as shown in the showcased here are a trendy innovation to reduce dependence on regular drinking straws. Tasteless pasta made of wheat and water fruity apples made from leftover apple fibers or sweet sugar straws are available for whatever beverages one wish to drink whether it is something fizzy, fruity or alcoholic.

When used these straws last for nearly an hour and can serve as a sweet snack along with your beverage. If you would like a less intrusive experience pasta straws provide no taste and are even suitable for hot drinks. Regardless of your choice all straws can be eaten or are 100 percent biodegradable. Food film: Researchers from the university of Nottingham developed edible and 100 percent biodegradable food films using plants bred carbohydrates such as konjac flour starch cellulose and proteins. This innovative food packaging film offers better storage, safety and shelf life while being much more environmentally friendly than plastics.

Eco bags: Indonesian company Avani developed a consumable biodegradable eco bag from a cassava root that can dissolve in warm water, but the intention of this bag was not to be consumed by humans. Avani's eco bag nourishes fish and insects when consumed

instead of poisoning them with plastics. Spoons, Bakes have created the world's first consumable cutlery line from rice flour, wheat and sorghum to come back plastic cutlery pollution. Designated to be fully vegan with no trans fat or preservatives this company aims to create an eco friendly eating utensil suitable for mass audiences. With over 40 billion plastic utensils used yearly in United States alone cutlery plays a massive role in environmental harm caused by the food industry by Beckys aims to lessen that impact.

The bottles, The edible bottle is the leading consumable alternative to plastic bottles developed by skipping rock slab Ooho uses a technique popularized in cooking. Spherification by utilizing a double membrane of sodium aginate and calcium chloride skipping rock labs developed a transparent gel walls solid enough to hold liquid in a spherical pouch like container. Unlike a traditional plastic water bottle this container is completely consumable and leaves no waste behind. The materials for edible packaging There is ongoing research into the possibility of replacing synthetic and petroleum based packaging with biologically based biodegradable materials. Bio based and biodegradable materials can be categorized into three categories based on the sources from which they are originate are as follows.

Materials developed from direct biomass or natural sources like proteins, polysaccharides and lipids. The materials this is the extracted from the biomass the materials produced from microorganisms usually belonging to the specific types of polysaccharides like this derived from naturally occurring genetically modified microorganisms. And the materials produced from bio based monomers that is the poly lactans this is the synthesized from the bio derived monomers. The PHA stands for the poly hydroxy alkaloids and PLA poly lactic acid. The edible packaging materials are a subgroup of bio based and biodegradable materials and have been extensively studied as an alternative to the traditional food packaging from the aspect of their film formation properties.

Biopolymers used as edible materials are classified as polysaccharides, proteins, lipids and composites. The examples are polysaccharides are starch, gums, pectin, cellulose, alginate, agar, chitosan, chitin etcetera. Whereas, the examples of proteins are collagen, casein, cornstin, gelatin, soy protein, pea protein, wheat gluten etcetera. The examples

are lipids for example, paraffin wax, bee wax, mineral oils, fatty acids and vegetable oils. And the composite materials are bilayers, multistacks, conglomerates, blends etcetera.

The development of edible packaging, the ultimate goal for packaging is first and foremost to protect the and preserve the product. Since many common resources used in edible packaging consist of some shortcomings, the packaging is usually made with several different components to balance and support each other's weaknesses. Secondly, to be eaten or biodegraded without harmful environmental impact, one should not want to include synthetic toxic materials such as plastics that would be counter intuitive. Natural materials such as wheat, seaweed, alginate, fruit or plant fiber should be considered in combinations that complement each other. After selecting the appropriate materials, films and coatings are created by emulsifying or dispersing film forming polymers into a solvent such as water or ethanol.

It is then applied directly to the food items with the assistance of the solvent. Finally, though a good amount of consumable packaging on the market may include complementing tastes, the packaging should have a neutral or tasteless flavor in most cases. The reason for this is that if the taste is too strong, there is a risk that the item inside will absorb the flavor and compromise the product. To avoid this always considered tasteless or subtle complementing flavors to accompany your product. The preparation of edible films or coating, here the product selected for edible film coating is dispersed in the water or alcohol and then it is homogenized and then it is degassed.

After that if we want to make a plastic film, then it can be casted, dried, detaching and the film is made. Otherwise after degassing, it is goes for the direct immersion of the fruits for or spraying to make a edible film coated the fruits. The application of nanotechnology in edible packaging. Nanotechnology is enabling the novel development of nano scale edible coatings around 5 nanometer thickness which could be used for packaging meats, cheese, fruit, vegetables, confectionery, bakery goods and fast food products. The advantage of nano scale edible coatings is that it provides a barrier to moisture and controls gaseous exchange.

At the same time nano coating can act as a vehicle to deliver colors, flavors, antioxidants, enzymes and anti browning agents and could also increase the shelf life of the

manufactured food. The potential benefit of nano chemicals are different from the same materials in bulk or with macroscopic dimensions. Food based nano materials have been part of food processing for centuries since many food structures naturally exist at the nano scale dimensions. Usage of nano materials in the food industry covers many aspects such as food safety, nano sensors, nutrient delivery systems and enhancement in bio availability, new materials for pathogen detection and packaging materials. Typically nano packaging is produced with nano particles or nano materials that exhibit chemical and physical properties that different from those of larger particles.

The use of nano structures such as nano hydrogels, nano emulsions, nano particles for the incorporation of bioactives are expected to increase the potential applications of edible packaging as active and further enhance smart packaging options. Now, the nano particles, nano particles usually provide both enhancements of mechanical, physical and barrier properties of edible films and coatings and can also serve as encapsulating system for active components. The incorporation of nano particles into edible materials serve as delivery system for active agents. In most cases this has led to the development of a variety of nano particle reinforce edible materials so called nano composites. Furthermore edible films containing nano particles can be customized and achieved suitable outcomes for the packaging industry including better mechanical properties and customized barrier performance.

The most used nano particles include silver, gold, iron, zinc, zinc oxide, silicon dioxide, titanium dioxide, titanium nitride, alumina, iron oxide, copper, copper oxides, gallium and palladium. Their incorporation in edible materials or preparation of nano composite for packaging solution should be taken with caution as there is small size increases the potential for migration into foods due to their larger surface area thus increasing the possibility of self penetration and free movement within the body. Now, the nano encapsulation, nano encapsulation is a technology that is used for packaging substances in capsules with sizes in nanometric dimensions and the capsule actually enables the final product functionality such as controlled release of the core active substance. Nano emulsions also allow the proper delivery of bioactive agents increased bioavailability and better stability of these compounds. Therefore delivery of active agents provide food

products with better physiological properties, microbiological protection and improves the products nutritional value and organoleptic properties.

The most common application of nano encapsulation in food industry and particularly in packaging is to deliver the active agents to solid foods, encapsulated essential oils and nano emulsified edible materials. Nano emulsions have also been used to encapsulate antimicrobial compounds that extend the food shelf life and increase food safety. They can be either directly incorporated into food systems that is functional food, but also entrapped in polymer matrices to produce active or edible packaging. Nano lamination and layer by layer deposition. A nano laminate consists of two or more layers of material with nanometer dimensions that are physically or chemically bonded to each other.

Coated foods with nano laminates are usually prepared by dipping method in a series of solutions containing substances that will be absorbed by the food surface or spraying substances on to the food surface. The implementation of layer by layer method allows the buildup of active films or coatings over the food product with precise nano level tuning of their properties. Edible coatings prepared by the layer by layer approach in general have advanced mechanical properties in comparison to the blended films. They usually provide excellent adhesion to the coated surface and between layers. Appropriate firmness sometimes antibacterial benefits, gloss, color control the ripening rate and off flavors.

The multilayered stack could be developed from food grade materials like proteins, polysaccharides and lipids and includes a variety of functional agents like for example, antimicrobials, antioxidants and flavors that enhance the food stability, safety and quality. The advantages of edible food packaging, there are many advantages like it is an integral part of the food product, extends shelf life, controls materials exchange, convenience and quality preservation, it improves the sensory properties, it tailors the barrier functions, it adds nutritive value and or function, can be safely eaten, it is in environmental friendly and the physical chemical and mechanical protection to the food. Challenges and limitations of edible package solutions, technological hurdles, developing edible packaging materials that can effectively preserve a wide range of foods while maintaining taste, texture and safety can be technologically demanding. Finding the

right balance between biodegradability and functionality is still a significant challenge. The cost considerations, the truth is that edible packaging materials often are more expensive than conventional packaging.

The production costs associated with sourcing and processing natural ingredients for edible packaging can pose financial challenges potentially leading to higher production prices. Food compatibility, not all food products are suitable for edible packaging. Unfortunately items with high moisture content or specific storage requirements may not be compatible with current edible packaging solutions limiting their applications. Climate and storage, environmental conditions such as temperature and humidity can affect the stability and safe life of edible packaging. Adding these materials to different climates and storage environments poses logistical challenges.

The consumer acceptance, this is a crucial factor in the success of edible packaging. While many consumers are eager to embrace eco friendly solutions, others may be hesitant to change their packaging preferences leading to potential marketing challenges. Regulatory considerations, the regulatory landscape surrounding edible packaging can be complex ensuring that these materials meet safety and quality standards while navigating varying regulations across regions can be a hurdle for manufacturers. Thank you very much.