Food Packaging Technology

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Week – 06
Lecture – 31
Edible packaging – Part 2

Hello and Welcome to another session in the Food Packaging Technology course. We are on Week 6 and we were discussing on the different advances in Packaging Technology. We talked about Active packaging, Modified, Atmospheric and Aseptic packaging. In the last class, we dealt with a very important topic which is bioplastics and today we'll be continuing with the same portion as it's very important in the today's settings. We're talking mostly on edible coatings, edible gums and how these can be a part of the food packaging industry. There's a picture that is taken from the particular source.

Now edible packaging consists of edible films, sheets, coats or pouches just like the bioplastic form of polymers. These are edible, you can actually consume them. Biodegradable polymers which could be degraded easily in nature. Edible packaging, it can even be consumed without any harmful effects.

At the same time, it has a protective or a barrier property which should protect, give an additional protection to the food. Now, edible films if you say, they have the thickness less than 254 micrometers. On the other hand, edible sheets, when you call them a sheet, the thickness is greater than 254 micrometers. You've got another structure which is known as pouches or edible pouches or standalone structures and they are preformed separately and the food is placed in them. Another type is the edible coatings, which are thin layers of edible materials which are directly added on to the food substances.

So these are the different forms in which these edible packaging can be made. Films, sheets, coatings and pouches. Now the edible films and coatings, they are again just like your biodegradable films. They are based on proteins, polysaccharides and lipids and these have a potential to increase the food quality and they can replace the food packaging requirements. Edible films are maybe as coats or the food may be placed in them and they might be limitations of migration of moisture, flavor, colors.

So they might not be as great as the normal thermoplastic, but they are a good replacement to a great extent. Now these are the pictures. This is the edible film which can be of different colors or edible coatings which can be on different sweets which can be consumed as a part of the food but at the same time it can increase the shelf life and the quality of the food. Now, what is the advantage of these edible films? As it is evident

you can imagine having burgers or sweets with the package. It sounds gross but it's actually going to help in the way that there is no disposable problem if you consume it along with the packaged product.

So, it's going to be eco-friendly. It can be produced exclusively from renewable edible ingredients, like I told you, polysaccharides or proteins or lipids and it's anticipated to degrade readily than your normal plastics. You can increase the organoleptic properties that's your sensory properties of the packaged product by providing color, flavor and sweetness to the package itself. You can supplement the nutritional value of the food by adding those nutritional supplements to the package. It can be applied inside the heterogeneous food at the interface between different layers or components.

Another important advantage can be tailored to prevent deteriorative inter-component moisture and solute migration. My edible package will act as a barrier so that the outer package will know migration will take place from the outer package into your food. So, it's like an extra barrier especially in foods like pizzas and pies and candies. It can function as a carrier from antimicrobial and antioxidant agent. So instead of adding these into the food you can actually add it to the edible packages.

These edible coatings can either be half consumed or it can be disposed whatever that is the choice of the consumer but actually it can function as a carrier for these kinds of extra nutrients. It can control the diffusion rate of the preservative substances from the surface to the interior of the food and can be used as a microencapsulation of food flavorings. Microencapsulation is one of the latest technologies. So, these food flavorings instead of they can be directly added on to these edible coatings so that the first taste or sense that you get is of these flavors. Okay. You get that bust of these flavors in your mouth when you bite into them.

What are the requirements for the edible films of the coating? Number one; most important they should prevent product dehydration. They should control the transmission of gases and vapors or and solutes you know from the loss of flavor nor ingress of flavor from outside. They should provide mechanical protection to the food from damage by squeezing a compression. They should prevent that. They should restrict microbial invasion which is a very important property.

They should have good mechanical properties. They should serve as a carrier for additives like antioxidants, antimicrobial agents, flavors or colors and the composition should confirm to the regulation that apply to the food which is the most important thing. There are regulations for the foods. You cannot comply to the regulations of food at the same time not have those regulations met by the edible coatings. The edible coatings

must confirm to all the regulations that apply to those food in which it is to be wrapped.

Now, the materials for edible packaging. You have polysaccharides and under polysaccharides you can use starch, cellulose, hemicellulose, chitosan, guns. Very similar to biodegradable plastics and you can have lipids and proteins. Let's look at these one by one. Just like biodegradable polymers, starch, edible starch films and coatings are mainly used in your bakeries, confectionaries, battles and meat products.

If you recall starch was made of amylose and amylopectin and because amylose has got a linear nature it forms a coherent relatively strong freestanding film. On the other hand, amylopectin is more branched so the film that you get from that is usually brittle and non-continuous. So, it's easier to get a continuous strong film from amylose rather than from amylopectin. And to increase the water solubility, partial etherification of the high amylose starch with propylene oxide can be done. And this will give you hydroxy populated derivatives.

These high amylose starch and the hydroxy propylated high amylose starch all these can be used as edible coatings on foots. It can be used as encapsulating agents to provide oxygen and lipid barrier and to improve the appearance, texture and handling. So, this starch is very important edible packaging and it can be modified to make, to improve its property as an edible coating. Cellulose is another edible film that can be used. Numerous hydroxyl functions in the cellulose resulting in strong hydrogen ball.

It creates a physical network that makes the material non fusible. So cellulose is insoluble aqua solution and to produce plastic materials from cellulose a chemical modification has to be done. There is one way that you have you can use cellulose as an edible coating. The most common cellulose ethers are methyl cellulose which is known as methylcellulose, hydroxymethyl cellulose, hydroxypropyl methyl cellulose and the most common carboxymethyl cellulose. All of these have got very good film properties and your methyl cellulose are excellent film making properties as well as high solubility and they've got more important the efficient oxygen and lipid barrier.

So both oxygen and lipid barrier is important because you do not want the lipids to ooze out from the food into the package and so this acts as a very good oxygen as well as lipid barrier. Coming to hemicellulose which can be used as an edible film, there have been a number of studies on hemicellulose for edible food coatings based on beta glucan extracts from barley, hull as barley and oats and even from corn hull. Xylans from birchwood, from grass and from corn cob, these have been used as an additive in wheat gluten and this helps to form an edible composite film. So, these xylans can be used along with has been used to be making a lot of edible coatings. Chitosan we saw the same thing when

you talked about biodegradable plastics.

Chitin after cellulose is one of the most abundantly used polysaccharide based edible coating especially, they are abundant in your exoskeletons or the shells of arthropods and the cell walls of insect cuticles. So, what is the effect of chitosan coating on the shelf life of fresh cut fruits and vegetables? They have found that they have got a very good or a positive effect on the shelf-life of strawberries, carrots, mangoes, cantaloupe, mushrooms and all these cases because, I told you, chitosan has antimicrobial properties so all these cases microbial growth has inhibited and shelf life has increased. Gums very important. The alginates which have been extracted from brown seaweeds of the Phaeophycean family are they're actually the salts of alginic acid and this is a linear copolymer of D-mannuronic acid and L-guluronic acid monomers. So, films that are produced by the evaporation of water from a thin layer of this alginate solution they are one they're impervious to oil and grease they have lipid barrier they've got good barrier against oxygen but they have high water permeability and that is a problem it's not a good barrier against water but it is a good lipid and oxygen barrier.

Carrageenan is another gum other than alginates that has been applied to a variety of foods and these can help to carry antimicrobials and to reduce moisture loss, oxidation and disintegration. Agar is another gum also that comes under this category. These agar forms strong gels that are characterized by melting points which are much higher than the initial gelation temperature. So, agar coatings containing water soluble antibiotics and bacteriocin nisin have been used on flesh foods. So, gums including alginates, carrageenan and your agar they're excellent as edible gums or coatings.

Now these are some of the commonly used polysaccharide-based hydrochlorides and these are the main characteristics taken from this paper. Chitosan, sodium alginate, starch, cellulose, pectin. So, all of these polysaccharides; chitosan are from exoskeletons; their packaging characteristics are they're soluble in weak acids, good barrier against oxygen and carbon dioxide but they're hydrophilic. We have mentioned this. Sodium alginate produced by and refined from various brown algae or from the bacteria as exopolysaccharides.

Now these are very soluble in water and they tend to form lumps with insufficient shear. They form gels in the presence of cations. They have low tensile strength, not rarely used. Starch is very important. It's isolated from plant roots, stalks, crop seeds.

They have got tensile properties that are suitable for the production of packaging material. That's why I said starch is an important polysaccharide. Cellulose, again made isolated from plant cells. Great forming properties, increased solubility in organic

solvents and they're also good gas barrier in low moisture environment. Coming to pectin which is another polysaccharide from plants.

They've got great gelling properties, hydrophilic property. It has a tendency to form gel in acidic conditions. The problem is they have got poor water vapor barrier and low mechanical properties. So, some of the common ones, chitosan and starch are some of the popular edible coatings from polysaccharides.

Coming to lipids. Lipids are another class of edible films that can be prepared. Lipids like bee waxes, rice bran, paraffin wax, acetylated monoglycerides etc. These have been used for making films. Wax has been used to coat your cottage cheese and fruits etc. You must have seen how these fruits exported with these lipids or these wax around it prevents dehydration, keeps the shelf life better, quality better.

Now lipids are hydrophobic and therefore they will be a good moisture barrier. But however, there are mechanical barriers inferior to proteins and polysaccharides. So, if you want to make a good water vapour barrier, lipids are a good choice but actually compared to your proteins and polysaccharides, their mechanical properties are much inferior. Proteins, another class of edible films. The first one among them and the most popular is your wheat protein.

Now wheat protein films are brittle because of the excessive intermolecular force. So, here you require plasticizers that will reduce the force and will increase the mobility or that makes it more flexible. Chains become more flexible when you have the plasticizers between them. It's something like adding oil between your hinges to make it more flexible. However, resulting loose character will reduce the ability of the film to act like a barrier.

That is another problem. It might become more flexible but the barrier properties reduce towards gases and vapors. The greatest obstacle for exploitation of this is the highwater vapor permeability. They are not a good water vapor barrier. So edible packaging films and sausage casting are made from a blend of collagen and gluten. So, you can make a combination of collagen and gluten if you want them to make it as an edible coating which adds to the properties of the films.

Another protein other than the wheat gluten is your corn protein. Corn protein, it is zine, it's the only protein that is commercially produced. It is characterized by its ability to form tough glossy that is shiny hard grease proof coatings after evaporation of the aqueous alcoholic solvent. So, once you remove the film that you get is going to be a better mechanical property. Now these have been used for pharmaceutical tablets and

candies.

They have been formed by spraying or dipping the product into aqueous ethyl alcohol isopropyl alcohol solutions of zine. The solutions also contain the plasticizers which are proved. These plasticizers may be the glycerin, your propylene glycol or acetaldehyde glycerides. Now once these solvents are evaporated you get this shiny glossy protective zine for films and that can be formed on the surface of the product. So, this is a very commercially useful edible coating.

Another protein that is used is the milk protein. In milk proteins, casein is the major of the milk protein. Highly concentrated cure solutions of casein, they're firmly gelatinized, very closely cross-linked and that is by using transglutaminase and results in a film which has got good tensile strength, good stretching property, elastic property. So, this trans glutaminase is a calcium dependent enzyme that catalyzes the formation of covalent glutamyl-lysyl cross-lens. So, this once these enzyme helps in this cross linkage, these films become insoluble in water, bulk kept ethanol and in guanidine hydrochloride.

So pure caseinate films are attractive for use in food products because; they're transparent, they're flexible in nature and they have solubility in water. The table is showing some of the commonly used proteins that are used as edible coatings and their main characters. Casein, collagen, corn zine, gelatin, soy protein and gluten. Casein, we had already discussed. Collagen, it's extracted from animal connective tissue, good barrier against oxygen and solutes.

They are hydrophilic, poor mechanical properties. Corn zine like we said it’s commercially available. Gelatin is produced from collagen by thermal denatured. Partially denatured collagen is gelatin. It's got amphiphilic behavior.

Plasticized films show good mechanical properties. They're odorless and tasteless. But the problem is they have got poor water vapor barrier. Soy protein, they extract it from soybeans. Poor mechanical strength but high-water sensitivity.

So, not really used in the packaging. Wheat gluten extracted from wheat. These again have got poor mechanical properties like we saw but they are biocompatible, soluble in alcohol and frequently they are cross-linked to give it more better properties. These are some of the commercially available edible chitosan and gelatin coatings. These are the names. In UK, you have this company of Agri-Coat Industries with the brand name of Semper-fresh.

Nature-Seal is another brand which is given out by the company of Ecoscience and

Natural Shine 9000 in the US and Pro-long in London. These are some of the commercially available chitosan and gelatin coatings that are available. This is one of the ways in which the films are casted.

These edible coatings of films can be cast. You take these lines that you see here. Those are the biopolymers depicted as these curved lines. Plasticizers are depicted as these red dots and the green triangle is the reinforcing agents like nanoparticles essential. Any extra component you want to add along in the package that is depicted by this green triangle. So in the first case you'll mix these components together, homogenize them under very high speeds, degas them and once you can add all these your other extracts, in this case you've added this propolis extract is added and once that is formed it is cast the particular thickness that you want for on a flat plate depending on the solvent is evaporated can peel off that edible coating and get a film with propolis extract in this case or whatever component you want to incorporate.

This is a depiction of the way in which you can make an edible film using film casting. But moving on to edible gums. So, gums are polysaccharides themselves of natural origin and they utilized as thickness and stabilizers or clarifying agents, gelling agents or even as emulsifiers in the food sector. So, they come from actually seed gums, you have mucilage gums, exudate gums, they come from a different variety of sources. Now these are biodegradable and sustainable alternative to your petrochemical based films and coatings.

Gum is an excellent option towards all these thermoplastics that you'll have. So natural plant gums based edible packaging they will ensure the extension of shelf life of fresh and processed foods mainly by reducing the microbial load and the oxidation process. They are a good barrier against most of these. Polysaccharide based gum edible coatings you can use cellulose, agar, pectin, tara gum, locust bean gum and gum arabic.

All of these can be used as the gum based edible coatings. These are some of the methods in which you can coat the product with these gums. You have pan coating, drum coating them, fluidized bed coating or spray coating these gums directly on this. All these methods will help, ensure, to get these gums which are edible. Now coming to the last part which is the application. So I have mentioned just five applications and research in the papers that have been mentioned here.

One is using chitosan. They use this product; mango was used, they made a film out of that. These mangoes were kept in carton boxes that were covered with the chitosan films and they were stored at 27 degrees centigrade and 65% relative humidity. The shelf life of the mangoes increased with no growth of fungus and flavor and the color of the

mangoes were also maintained that gave positive results. Another is the wheat gluten.

They had used this in refrigerated strawberries as a coating in a film. So, there was a bilayer of wheat gluten along with lipid they had combined this and this was applied to refrigerated strawberries and the results they got firm strawberries and there was a reduction weight loss also. Further going, they again used chitosan in pork sausages as an active film. Green tea extracts were incorporated in the chitosan film so in the edible film itself you could incorporate whatever component you want. In this case they incorporated green tea extract and this was used to package your pork sausages stored at 4 degrees celsius.

They saw high inhibition of microbial growth and low growth of yeast. Similarly, PLA was used in ready-to-use salads as a film. This PLA incorporated with alum species extract that is your garlic extract. It was used for packaging ready-to-eat salads in a controlled atmosphere. So, the films that contains 5% and 6% of this extract it showed antimicrobial activity mainly for fresh lettuce and a decrease in the Enterobacter. So, all this shows that there is a promising future for edible packages not only in the case that it helps in reducing the environmental pollution but it also reduces cost in many cases.

You're going to have de-biodegradable edible coatings which will actually help you increase the quality and the shelf life of the product. I hope it was an interesting session. We'll see you all in the next session. Thank you so much.