

Food Packaging Technology
Dr. Maya Raman & Dr. Jenny Ann John
Department of Food Science & Technology
Kerala University of Fisheries and Ocean Studies
Week – 01
Lecture – 02
Introduction

Welcome to the new NPTEL. In this NPTEL course, we will discuss the different topics that will be dealt in this course. This course will be handled by two faculty members. The details were also discussed in the previous video. We will be starting Module 1 with these videos. The coming classes you can see what are the different topics that will be dealt in the session.

So in the Module 1, we will be giving a brief introduction about the food packaging and we will also discuss about the need for food packaging, why your food packaging is required and why this sector of food industry is getting so much attention in the recent years. We will also discuss about the role of food packaging and what it does actually by extending the shelf life and preserving the nutritional qualities. These three topics will be dealt in the first week. In the coming week, we will also discuss about the different types of packaging materials and their characteristics and their uses because it's not necessary that same packaging material has to be used for all kinds of foods.

It differs from food to food and this depends upon the property of food as well as property of the packaging material. So, those things will also be discussed. We will also discuss about the paper as a packaging material and how to develop the paper. Right, from the raw material that is the wood how it can be converted to a packaging material and what are the different types of papers that has been developed? What are the applications of these papers in food industry and how to test the property of different papers? The test methods will be discussed in detail in the coming session. It may not be discussed in this module but in detail you will find in another module and following the paper we will be discussing about glass as a packaging material.

Glass is an inert material and has been in use for a very long time and we will also discuss about the composition and properties of different types of glass and how to develop a bottle? What are the different methods that can be adopted to develop food packaging materials using glass? Again, the glass has been replaced with metals because glass being brittle it breaks easily. So, we will also discuss about the tin plate containers or tin free cans. We will also discuss about aluminium containers and what are the role of lacquers? What is the importance of this canning industry? Finally, in this module, we will end up with plastics? What are the different types of plastics that are in use in food industry? What are the different laminated materials or flexible materials that are currently being used for food processing and food storage? Now coming to the introduction part, packaging it's a safe, acceptable delivery of plant and animal derived food products. So, it is from the production site, from the place of production to the consumption and also the agriculture economics it is converted to industrial ones.

So, these are the three important points that are associated with packaging. So, first point is safe and acceptable delivery that is any food which is derived from plant and animal sources they need to be packed, they need to be protected and it has to reach to the consumer in safe position without any change in the nutritional qualities. So, that is what packaging is doing and again it should be in the acceptable form because packaging is the outermost cover and like the saying goes first impression is the best impression so it is the first impression the consumer gets the first impression about the product by looking at the packaging. So, if the packaging is good consumer will have a tendency towards looking into it or they may pay attention to the product. So acceptable delivery is very important for the marketing of the product.

The product it has to reach to the consumer it may not be near to the consumer it may be produced in fields or it may be fish it is from ocean it has to reach to the consumer. So, from the place of production till it reaches to the consumer the distance is very long and throughout the journey the nutritional quality has to be protected without any change where packaging plays a very important role and also what are the agriculture economies what is produced in the field it has to be converted to a processed product. So, if it has to fetch a market if it has to fetch a fair in the market there should be any economic value it should be converted into some produce. Agriculture produce is converted to industrial produce it gets or it fetches the fair and there again packaging plays a very important role. Now packaging it protects the food from deterioration.

So, as we all know food undergoes different types of deterioration it can be biochemical deterioration, it can be enzymatic microbiological or physical deterioration. When a food is harvested it can be an agriculture product or it can be an animal product. The moment the animal has been killed or it has been harvested it undergoes some by chemical changes so it can be glycolysis anaerobic reactions or ATP degradation. So, this kind of biochemical deterioration they have a close association with the quality of the product. Again, the enzymatic action may also happen if it is a fish product may undergo enzymatic action or if it is a food product the overwriting may happen.

So, these are enzymatic changes if it is not arrested properly or if it is not taken care of the quality of product may change. And again, if it is not processed the surface of the food product, they may contain microorganisms which may penetrate inside the tissue. For in case of fish or the animal product the gut harbors a lot of microorganisms, if the temperature is not brought down and then microorganisms, they may escape from the gut region and they may contaminate the tissue. So that is again a source of contamination and deterioration. By physical contamination we mean any rupture or any stress that is faced by the product.

So, these are different kinds of actions that may happen in a food product and which will ultimately lead to deterioration. And the idea of food packaging is to reduce this kind of deterioration by and also to protect the nutritional quality. And this deterioration they are influenced by temperature. So that's the reason why we bring the temperature down that is increasing or chilling or we go for cooking that is raising the temperature. Also, humidity plays a very important role.

So, what is the relative humidity that is also need to be taken care of and what is the composition of gas because oxygen for example it induces or it triggers the rancidity. So, in fatty foods the contact between the oxygen needs to be cut off so that again gases also have a very important role. So packaging materials they try to cut off these things they cut off they try to cut off the contact of food with the gases they also try to maintain the humidity and also try to maintain the temperature. So, if it can do all these three things then packaging is the material is a very efficient one and it can be will extend the shelf life the food also retains the nutritional quality. Now packaging has been defined differently.

The first definition was put forth by EU directive 1994 and the directive number is 94 bar 62 EC and according to them the packaging can be defined as all products made of any material of any nature to be used for containment protection handling delivery and presentation of goods from raw material to process goods from producer to the user or the consumer. So, this is the definition which was given for packaging by EU directive. International packaging institute they have also given a definition for packaging. So, it is defined as the enclosure for products or items or packages in a wrapped pouch, bag, box, cup, tray, can, tube, bottle or another container. These are different forms of packaging materials and which performs one or more of the following functions.

So, it can be containment, protection, preservation, communication, utility and performance. So, if you look at the definitions over here the few terms like containment, protection, preservation, communication, these are repeated in the definitions. So, whether it is a definition by EU directive or by the packaging institute the following functions are considered in the packaging. There are other definitions also according to which packaging is a system that coordinates the preparation of goods for transport, distribution, storage, retailing and end use. A way to ensure its delivery to the consumer in a safe and sound condition.

It also includes a techno commercial function in order to optimize the cost of delivery while maximizing the profits. So, this was the other definitions. So, in this slide, the global food packaging market is discussed. It was reported that in 2020 the packaging industry earned around 323.81 billion dollars and it is anticipated that it may grow to 478.18 billion US dollars. So that shows the scope of industry and how much it will increase and there are few driving factors which are associated or which are connected to the packaging industry. For example, there is a rise in consumer demand for packed products and this has also been influenced by with the COVID conditions which had arised in the previous years. This has changed the consumer perception and consumer is also demanding more and more for the packed products and their eating habits has also changed and the lifestyle is also changing. So, for these reasons again the packaging industry is evolving, it is coming up. In the packaging industry, the sustainable packaging is gaining more interest in recent years because in packaging industry we use different kind of packaging materials and now the environmentalists and the scientists they are trying to develop packaging systems that will not harm the environment. So, the sustainable packaging has become a mantra and the idea is to develop eco-friendly. Even

the biodegradable and edible packaging systems are also coming up in this contest. There is a restraining factor in the packaging material or the packaging industry that is the pricing cost of the material.

The cost of material is increasing day by day and it is rising tremendously. So that is an impeding factor here and that could be an alternatives can be found for that then again, the packaging industry will boom up. Now if you look at the slide over here you can see that the major share is contributed by the bakery and confectionaries. The rest of the other sectors like fruit and vegetables, dairy, meat and poultry, on seafood sauces, dressings, condiments and others they contribute much lesser. So, it's the 37% of the total packaging or the global packaging market is contributed by bakery and confectionaries.

In Asia Pacific it contributes to around \$112.65 billion in 2020. So, this is the reports taken in 2020. So, from Asia itself half of the earnings is generated. So that is the major contribution that is 50% contribution is coming from Asia Pacific.

Now packaging materials have been in use for a very long time. From early ages itself we have been using different kinds of packaging materials. Actually, it was the leaves, different kinds of leaves were used for packaging and we were using baskets, bamboos were used for developing baskets, we were also using coconut leaves for developing baskets and mud was used for developing jars to store liquids and to transport materials and then grains they were stored in bags. So, these are some of the packing materials that were in use earlier. And what is the need for packaging? As we all know food, it's a perishable commodity, it perishes very easily and this is because it contains a lot of components and the first major component is water which is a major contributor and the other major components are lipid, carbohydrates, proteins, we also find micronutrients like vitamins and minerals.

And since food is rich in either one of these components, it may be proteins or it may be water or it may be lipid, so these are prone to degradation and again food it gives energy, it is a source of protein for human beings, so these things need to be preserved and by preserving we mean that we reduce the water content, the moisture can be removed by drying or it can be frozen or it can be heat treated. So, if we arrest the water content, we can also control the water activity and microbial activity and that will also indirectly prevent the deterioration of lipids, carbohydrates and proteins. So therefore, in one word food is very important, it contains all major components and it need to be preserved for all the metabolic activities in the human body or the animal body. So, it is a source of energy and it is required for the tissue building. Again, food has its own aroma and taste which is contributed by the essential oils or the volatile components that are present in the food and if these components are lost the food will also lose its integrity, so that again this need to be protected.

The idea of packaging is to extend the shelf life and to give a quality product. It means that it should be safe in all dimensions and the packaging material it should be designed carefully and manufactured carefully so that it does not influence the product and there

will not be any diseases which will be transmitted from food to animal or human beings. So, food it undergoes different kinds of deterioration, it may be biochemical, enzymatic and microbiological deterioration and this damages the food products. Again, damages may happen during transportation, during handling and the product may also lose water or it can gain water and so packaging it tries to interfere with this and it tries to control these factors. So, packaging in brief it tries to minimize the moisture gain or moisture loss and it preserves the food as such and also it tries to protect the food from bruises or any cellular damages during handling because these triggers the enzymatic deterioration, it causes the release of enzymes which will faster the reaction.

So again, packaging material first thing is we should not go for this kind of damaged or bruised products for processing and if we have a product intact product then it needs to be packed and stored properly so that it does not get any deteriorated or does not get bruised during further handling. Also, temperature is another factor, temperature increases the speed or its speeds of the deterioration reaction. So, these factors, the physical factors and the chemical factors and the biochemical and the microbiological factors all these factors need to be controlled during the packaging time or during the processing conditions. So, packaging it plays a very important role in controlling all these activities. It can be reducing the temperature, it can be reducing the contact of gases, it can control the gain of moisture or water and ultimate idea of packaging is to preserve the product.

So it extends the shelf life and at the same time it will retain the nutritional quality. So that is the main motto of using a packaging material. The processing, packaging and environment it goes hand in hand. If you take the shelf life of food it is equally important of processing, packaging and environment. So, we cannot say that packaging is more important than preservation or processing or processing is more important.

All the sectors of food industry are important and packaging, bringing the food from the place of produce to the consumer so it can be in the bulk process or it can be in the bulk form and then bulk packaged foods they are converted to small retail packs or they are converted to complex processed foods. Again, the packaging can come into play a very important role. Ultimately when it reaches to the consumer there also packaging plays a very important role. So, packaging it has a role at each level. Now from the business perspective packaging it prevents the breakage.

So, for example if we have a lace, we are all familiar with lace. It's a crispy product. So, if we get a powdered lace nobody is going to eat it, feel like having it or buying it. But the packaging material, the inert nitrogen inside the lace container or the lace package it helps to protect the contents inside and it is not broken or it is not powdered.

So that is one example. If the lace pack is very intact, we will be tempted to buy it. So that is how it protects the contents inside. Again, it bridges producer and consumer. So, what are the information that producer wants to share with the consumer that will be labeled on the packaging material.

Again, it decides the buying decision. Consumers when they go to the shop whether a

product need to be bought or not this decision is very much influenced by the packaging condition or a packaging material. For example, you look at the Maggi package it is yellow in color and you have EPI noodles which is the packaging material is red in color. So that is a driving force for children or the people who are buying this kind of product. Just by looking at color of the product they will understand that this is a Maggi and they will be tempted to purchase it. So, it has a very important impact on making decisions.

Again, it helps in promoting brand recognition. The same thing the yellow color is associated with that Maggi. So, we all have this kind of perception that lemon yellow color is for Maggi. So, any cover or any packaging material which has similar yellow color we will think that it is Maggi. The brand color or brand recognition is also associated with the packaging material.

Then it helps in product to stand out. It also evokes a sense of belongingness and creates a positive expectation and also a wider audience. So, these points are in the business perspective where the packaging is very important. So, role of packaging it represents inherently cultural necessity and it is results from the separation in time and space of food producer and from food consumer and the core idea behind packaging is to move its product from producer to consumer. So, there are four different functions of packaging that is containment, protection or preservation, and convenience in transport and communication or information.

So, these are all interconnected functions. You cannot go without one. All these four functions are very important in a packaging system. Now coming to the containment, the word indicates that it can contain a product. So, it's a container. It can be a container that can contain the food and it will protect the food from contamination.

So, it will also isolate the food from other environmental factors like light, gases, microbes, other physical contaminants and again the containers they can be flexible or rigid containers like cans or it can be flexible pouches or bags and in the rigid containers or variable volume packages, head space is very important because it maintains the gases and also this is intended to eliminate the gases which may react with the food content. If there is no headspace, the contents may leak out, it may be overfilled and the package may collapse also. So, in both rigid and flexible packages, headspace is very important and also this headspace it should not contain any oxygen because this oxygen may react with the fat in the food and it may cause oxidative rancidity. The next function of the packaging material is protection or preservation and it has to protect the contents inside.

For that we can use metal containers. Usually, the metal cans are used for canning and these are hermetic containers. Hermetic it means airtight containers which does not allow light, gases or other contaminations to enter inside the container and we can have a two piece can or three pieces can depend upon the number of pieces. Two pieces can they are more commonly used nowadays and because they are easier to handle. This is an example of how the can sealing happens. So, if you look at the figure here, we have a gasketing here, it's a layer of a rubberized layer which helps in maintaining it airtight.

We also use epoxy materials to protect the material from corrosion. These epoxy materials they are called lacquers and these lacquers they are put on the metal layer and which is put as a single layer over the metal and it protects the metal. But there's a confusion that this epoxy-based lacquers or coatings they may mimic the estrogen effect and they may be toxic to the human body. So, we were in earlier times cans were glass material and glass bottles and it was because glass is inert and impermeable to many gases and microbes. It also prevents physical contamination and tinted glasses can be used to protect the contents from the light.

Usually, such bottles are used in case of wine and flexible pouches very much in use now and it contains aluminium foil which is impermeable and the thickness of this layer is just below 20 microns and now most of the food industries they are going into the flexible packaging system. So, packaging it increases the shelf life and by shelf life it means the duration of time that the package would maintain a degree of safety and product quality acceptable to its eventual consumer. Now transportation or convenience in transportation. So, once it is packed how conveniently it can be transported from the place of harvest to the consumer or to the processor and also what is the time taken. So, we have to reduce the time or delivery time and also it should be intact.

Also, the food needs to be preserved or protected from the physical shocks and vibration because they are indirectly connected to the enzymatic reactions. So, for that also packaging plays a very important role and also to maintain the integrity of the food product. So, in the bulk packaging of fruits, we also go for different gases encasing the fruits in a plastic bag under controlled atmosphere is also adopted. Amount of oxygen and carbon dioxide is maintained at the appropriate levels which interferes with the ripening of the fruit.

So, the fruits will not be over ripened. So, this is a controlled atmospheric packaging and it is also adopted and all these things it helps in transportation of raw product to the processor or to the consumer. Now the last important function is information and communication on the product on the label packaging material producer should put all the information that need to be passed to the consumer. So, it should contain all the nutritional facts about the product, the brand, the ingredients that are being used any if any preservatives or additives have been used that also need to be mentioned. For example, if they are allergic to the product gluten or if they are allergic to milk products, they can avoid such products.

So, for those reasons also labeling is very important. The packaging material we have seen that packaging has a very important role in protecting the food and extending the shelf life. At the same time the role of packaging on environment health that is also very important. So, most of the packaging materials they are used one time and they are discarded. So, we need packaging materials that can be reused or it can be recycled. And there are economic constraints about the amount and nature of packaging materials that are suitable for reuse, recycle and reduction in volume or weight.

And the packaging reduces food degradation and also reduces wastage. And FAO they

are giving more emphasis to the packaging industry where we can reduce the global food waste and we can also reduce the waste generated from the packaging industry. So, if we can reuse it that is very important because the degradation of plastics is very slow and sometimes it is converted to microplastics also which enters into the system of a living organism and it is hazardous and lot of studies are being going on in this area of science. And US Environmental Protection Agency has identified 28 countries where they encourage the reduced packaging and recycling of packaging discards. And immediate concern is the toxins that are released from these packaging materials to the environment.

One such byproduct is the microplastic that is a very important concern now. And also, the heavy metals that leach because the labels it may contain inks and that inks may have the heavy metals that may leach into the groundwater again that is another concern. And also, improper combustion of the packaging material they may release diet toxins which may enter into the environment. So, burning plastics is not suggested it is not recommended and again we have proper regulations in the country we should not go for this burning of plastics. And in US 19 state governments they have prohibited the use of heavy metals in packages and they have also set the limits for it.

It should be 200 ppm and EC directive similarly they have their own limits. And in California the Safe Drinking Water and Toxic Enforcement Act in 1986 they have come up with a term of Prop 65. This label shows that the product may contain toxins which may lead to cancer or reproductive toxicity. So, any packaging material which may be toxic or which may be harmful or which may be related to these conditions they need to have this kind of warning on the packaging material. Then another concern is migration that is what contents can migrate or leach into the product from the packaging material.

That is another concern. So packaging material it should be inert and it should not react with the food contents and nothing should enter into the food from the packaging material. So leaching need to be minimized or it should not be there. Again, one such instance is wrapping food in the newspaper. The ink from the newspaper it may leach to the food and it may be hazardous. And the European Union they have come up with a project and where they are studying the effects of migration and exposure to such migrations on food and health.

So, this project is called Food Migration. And based on the packaging the food can be classified into different types. One such class is fresh food and we have partially or minimally processed food and processed food. So fresh food they need to be handled carefully and to prevent the deterioration they need to be chilled and the temperature need to be brought down immediately or we can go for cooking using the high temperature processing. And in minimally processed food generally we go for pasteurization also use curing or refrigeration and processed food they have longer shelf life.

One such example is canning and freezing the food. So, this can be one type of classification based on the packaging materials. So, we had seen the classification of food as fully processed fresh or partially processed or minimally processed food. The

examples are also given in this table. And according to the US FDA the food can be classified into nine different classes. This is again based on the packaging system and some of these classes they are again grouped into subclasses.

And in the European Union food are categorized into eight different types. Each country they have their own regulations to classify the food. Now beverage is a separate industry and beverages they can be still carbonated alcoholic or non-alcoholic. The pressure is held inside the container and for this reason the container needs to be highly strong so that it can withstand the internal pressure. Usually, the glass containers are used for the still beverages and we also have carbonated beverages and for carbonated beverages we can go for aluminium cans, glass or polyester plastic bottles. Again, they should be able to withstand the high acidity inside and they should be thermally stable.

And now the industries are also using stand-up pouches which has flexible laminations and the high barrier properties so which can withstand the high temperature as well as it can prevent the movement of moisture and gases. Here, it is sensitive to oxygen and loss of carbon dioxide may also happen which may lead to off flavor and change in flavor. So again, it needs a proper packaging material and in some of the packaging materials that are used in beer industry they incorporate oxygen barrier layers or oxygen scavengers which will trap the oxygen so oxygen contact can be avoided. And again, beer package has an internal pressure of 100 psi and it is pasteurized at 63 degrees centigrade so the packaging material it should be able to withstand this temperature and pressure.

It should be free of defects and it should be highly stable. So, in this session we had discussed about different packaging materials that can be used in the industry and what are the needs of packaging material and role of packaging materials. So, we begin with a brief introduction and we have seen these different points. In the coming session we will be discussing about different types of packaging materials. Thank you.