

Food Packaging Technology
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Week – 04
Lecture – 15
Designing of packaging material

Hello everyone. Welcome to the fourth week of the food packaging technology course. I am Dr. Jenny John, Assistant Professor in the Department of Food Science and Technology at Kerala University of Fisheries and Ocean Studies, Kochi. Now that you have completed two modules on packaging systems and packaging materials, I will be dealing with modules 3 to 5. This week we will be going through the designing of packaging materials, testing of packaging materials and testing of package performance.

Now before we go into designing of the packaging, I would like to take you all through the roots of packaging. Let us see how packaging has evolved over the times. In the nomadic existence of man, the earliest materials used were, as you can see, leaves were used for wrapping the food. We had animal hides, then they had jars and pots made of clay and natural materials.

The glassblowing technology was developed in Egypt and China is credited to developing flexible packaging materials. Medieval packaging, they had wooden boxes and crates. Another very crucial time was in 1810. In 1795, Napoleon offered 12,000 francs for developing packaged foods and a suitable packet preservation technology for his armies. But it was only in 1810 that the Frenchman Nicolas Appert developed canning process using glass jars and he won the 12,000 francs.

And it is almost the same year, 1810, Peter Durand patented the tin coated iron cans. Going on, 1817, Sir Malcolm Thornhill created cardboard boxes that we see today. In 1908, we had cellophane developed, 1933, saran wraps using PVDC. 1957, the very popular bubble wraps were developed. 1959, the pop tab for opening cans.

There was a problem where you had to use a can opener each time, but in 1959, the pop tabs that you have for the carburetor beverages were developed. And in 1973, the very popular packages that we have today, the PET plastic bottles were developed. And today, packaging has evolved in many ways. And recently, eco-friendly innovations like biodegradable edible packaging are coming up. The packaging industry is able to adapt to this ever-changing needs and concerns.

Earlier, you had a linear economy where you have taken, make and dispose. Today, everybody is going in for a circular economy where you can make, use it and reuse or recycle it. Coming to the definition of packaging, which you all already know by now, it is a means of ensuring safe delivery to the ultimate consumer in sound condition at minimum overall cost. Why I'm repeating is this is one of the main things that we have to keep in mind while designing a packaging material. What are the roles in packaging? Containment, number two protection and preservation, communication, machinability and convenience.

Now, if you can classify packaging based on different levels in which it is done, you can divide it into primary packaging, secondary packaging and tertiary packaging. Now, the primary package is actually the package that comes in direct contact with the product. It maintains the product quality like the cans or jars. Cans that you can see in this picture is the primary packaging material. Now, that is put into the secondary packaging material.

It contains the product and the primary pack. Example, the case and the wrappers that unitizes the primary pack, but it doesn't come in direct contact with the food. It is for presentation and for protection. And the tertiary package are the cartons that you have, the transporting shipping cartons that you have, which groups the secondary cartons into pallet loads and shipping units. This is used for transportation, storage in warehouses and for bulk handling.

There is another picture which clearly shows the primary package put into the secondary package and that can be unitized in the tertiary packages. While designing a packaging material, there are two main packages. You have got the consumer packaging and industrial packaging. Consumer package is designed for the consumers. For their convenience, it has to have its appeal.

You have to look into the marketing consideration and the display. Here the main emphasis is marketing. On the other hand, industrial packaging, it is designed or focused on the handling convenience and protection during transportation. So here the main aim or focus is logistics. Many of you will know the requirements for an effective packaging, but let's go through it one by one.

Good packaging material, it should be non-toxic. It should protect against contamination from microorganism. It should be a barrier to moisture loss and gain and any ingress of oxygen, which is important. It should protect against odors and environmental toxicants. It should filter out UV rays, provide resistance to physical damage.

It should be transparent, not all the time, but it can be transparent for the consumer to see the product. Next it should be tampered resistant or tamper evident. It is also called pilfer proof. That is, you have the seals in the packages. So, if someone tampers with it or uses it, you will know when the package seal is opened.

So, a package should be tampered resistant. Now it should be easy to open. It should have dispensing and resealing features. It should be disposed of easily. It should meet the size, shape and weight requirements.

It should have appearance, printability features. It should be of low cost, very important. It should be compatible with the food and it should have features like unitizing groups of products. These are some of the main important requirements for an effective food packaging. And what are the factors that influences when you design? What are the things that you should keep in mind? Most important you should keep in mind the consumer behavior.

How would the consumer like it or how is it appealing to the consumer? That's number one. Competition. You look at the product, competitors' products and see how that is packaged. The product should be packaged better than that. Then you should look at the distribution channels, the production, manufacturing, what are the production facilities that you have, the technology, legal issues including environmental disposal problems, economic factors which is important, fact cost is not exceeded and social issues.

When you design the packaging, two important things are one is the material and then is the form in which the material is going to be put into. The choice that you take for the packaging material depends on the demand for the product. How is the nature of the product? Number two depends on the expected life of the pack. The need for re-closurability. Not all materials you cannot use it for re-closures.

If it has to be re-closed, you need to select the material accordingly. The desired product image and the last but not the least, the performance properties of the material. For example, the barrier offered to oxygen, carbon dioxide, water vapour is a very important point when you consider the material. So, the material of the packaging depends on the product that you enclose in it. And the second like I told you is the form in which the package can be made into.

These are only a few of it. You have got a wide variety of forms in which packages can be made into. Some of them are the rigid cans and drums, flexible aluminium foils, you have got glass jars and bottles, plastic cans and bottles, films that are used for bags,

pouches and wraps, paper and paper boats for bags, boxes and today we have laminates. Laminates are multi layers of different packaging material where each packaging material will contribute to the final barrier property. Another factor that you should keep in mind while designing is the manufacturing method. You have already learnt in the other modules about different manufacturing methods but I want to just highlight some of these.

One of it is the injection molding where you can shape plastic articles by injecting heated material into a mould. So, any of the hard rigid containers are usually made with the injection molding. Thermoforming where plastic sheet is heated to a pliable forming temperature that is it is softened. And once it is softened it is formed to a specific shape in a mould and it is trimmed to get the final product. And last one is the folded paper.

Folded paper you can use cardboard or thick paper placed material. It is folded into a predetermined shape to enclose the product. So, when designing rigid materials, you can use one of these manufacturing materials. But when designing the flexible packaging materials, you can use either blow moulding or cast filling. In blow moulding this involves using a jet of air to blow air into a moulded plastic polymer and this is passed through a circular die.

This melted plastic will then become a continuous tube which is inflated, flattened by rollers and then it is cut in desired shape to get double thickness film. Another method of making flexible packaging material is by using cast film. Here they have, they extrude the melted polymer through a flat die or a slot which forms thin sheets of film. Now we go into four different factors that you should keep in mind while designing a successful packaging.

Number one is product assessment. Number two is the hazard of distribution. Number three is the marketing requirements and last is the machinery consideration. Let's go through this one by one. When you design the packaging the first and foremost factor is the product assessment. Here you ask questions regarding the product, the nature of the product, what material is it, in which manner does it deteriorate.

That is the foremost question you need to ask and depending on that you design or you select the packaging material. Number two the size and shape of the product. Number three the weight and density. Then another important factor is the weaknesses in the product. Which parts can break or become loose or scratched and you design the product, the packaging material in such a way that it can protect the product.

Another consideration is the effect of temperature and moisture changes on the product

and last but most important compatibility. You need to see whether the product is affected by the packaging material in any way. So, these are the four different factors that you need to consider when you do the product assessment. Number one is physical state, general nature, factors that may damage it and four the packaging product. Now when you consider the physical state of the product you need to consider whether the packaging of food material is a gas, is it a liquid, if it is a liquid is it a viscous liquid, is it a paste, a powder, granule, tablet, capsule.

Now depending on the nature of the product or the physical state of the product the packaging design will change. Next you need to consider general nature of the product. Is it corrosive, toxic, volatile, odorous, perishable, sticky. These are things again that you should note and consider. Another one is the factors that may damage which is important.

What are the mechanical shocks that it may undergo while transportation or during storage, vibration temperature change, humidity change, oxygen, light. What are the factors that it will actually experience while it is being transported. So, these are another consideration that you should consider while you are doing the product assessment. The last thing that you should consider about product assessment is to find out how the package reacts with the product. Is it compatible with the product? Does it transfer any flavor? Does it cause erosion? Does it react chemically? And is it easily pilfered? I told you that word pilfered before, pilfered proof is is it tamper proof? Can the package be tampering proof to show the consumer that the product sealed not tampered with and does it stain easily? So, these are I have just listed out the basic packaging materials, the glass, metal, plastic and paper boards.

So, when you consider any product for example the jellies and sauces you need to have a protection against chemical and biological agents and damage and odor. So, you will naturally use glass which is most best barrier property which has the best barrier property. Another food that you can consider is milk. The milk, cookies and eggs which again needs protection from physical damage, abrasion and crushing. So, the first thing is you assess the product and design the packaging accordingly.

So for eggs and all you can use paper boards to keep it protected from any mechanical damage. I have also listed some of the laminates that are used for different packaging materials based on the property of the product. For example, if you take fresh fruits and vegetables, they have a property where they need to give off the water vapor and they require oxygen to continue with the respiration. So, we use materials like LDPE or thin gauge PP or even cellulose acetate for packaging fresh fruits and vegetables. While in the case of meat again you need an optimum oxygen production potential.

They need to retain their color, texture and they can be stored or they should be stored in low temperature. So here because of the product we can easily package it in LDP cellulose acetate or PVC film. On the other hand, if you have coffee one of the main requirements of coffee is that it should retain its aroma and it should be a moisture gas barrier. So, what are the products or the packaging material that you can use? You need to use aluminium foil for sure because that is the best barrier against gas ingress or even odor loss. So, you can use PET aluminium foil P or even HDPE or PP pouches or the OPP, PVDC or PE.

So, these are ways in which you assess the product and accordingly design the packaging material. For carbonated beverages that needs to resist internal pressure. It should also be less permeable to the carbon dioxide and other volatiles. So naturally one of the best packaging materials is either PET that we use or the aluminium cans. So, we went through the number one consideration while you are designing a product that is product assessment.

And the second most important consideration is the hazard of distribution. This is another thing while you are, these questions that you need to ask is what happens to the package on its journey to the consumer? What is the method of transportation? Is it air or rail? What are the probable storage conditions? And what is the duration of this journey? So, depending on that you need to design the packaging material. See some of the questions here. Type of transport. Is it going to be rail, road, sea or air? What is the degree of control you have over this transport? Is it going to be a private transport or is it going to be a public transport? Now form of transport.

Is it going to be a freight container or a postal or passenger train? What are the mechanical conditions and the duration of storage? Another thing is nature, intensity of the mechanical and climatic hazards. I will be dealing this in detail in the next session also. This is a very important portion. Another distribution hazard is whether handling aids are available for loading and unloading. So, these are the second point that you need to consider while designing the packaging material.

The third and one of the most important factors that you need to keep in mind is marketing requirements. Now the package is actually the image of the product. The package projects the product and also the company that sells the product or the brand. So, the package must enhance the projection to consumer and retailer.

The design should fit with the food. If the design doesn't fit with the food, then it is not possible for the consumer to go in for an impulse buying. So, the image of product or

package material for the product is very important when you consider marketing requirements. And the second one is another important one which is packaging and self-service store. See nowadays you have supermarkets and hyper markets coming up. So, most of the time it is the consumer who decides what to buy and when to buy and how much to buy.

And if you want to induce or stimulate an impulse purchasing in the consumer, you need to have a package that will suit this, which will give the necessary communication to the consumer. So, in addition to protecting against contamination, protecting against breakage, tampering with the contents, the product package should also be easy to handle. It should be attractive to see and hold. For example, you have got these squeeze packages or you have got finger contoured packs. And another important thing is this package should be easily stacked in the self-service or hyper market stores.

So, all these design material or factors should be considered while you are designing it. The last is when you are considering the marketing requirements, package and the price. A cost is a very important factor. The package should not add to the excessive cost of the final product. Now research shows that products packed in expensive, bigger than necessary units are failed very frequently.

When you design it for the market, design it for the consumer, consider it with competitors packs and also see that it is suitable for today's self-service stores and keep the cost at the minimum. Look at this, marketing consideration. One you need to consider the product. What is the competition you have? What are the competitors using? What are the packages that competitors are using? What are the quantities sold? What is the price bracket? Another factor is the retail service. Whichever product you are making, is it going to a self-service store or departmental store? Is it going to be a mail order like the online orders? And how do the competitors sell the same product? Another factor is you have to consider the marketing requirements is the consumer in itself.

What is the age, sex, income group and social level of the consumer? Another factor is the location of the consumer. Is it going to be a national, local or export product that you are going to have? So where is the consumer going to be? Accordingly, you design the product. Another thing 4M5 which is the package itself. So, the package itself you should consider for a primary package as we all know we should consider the size, shape, weight. Is the package going to be a gift package or for somebody or is it going to be a seasonal product? Is it going to be in a bag or pouch or envelope? What is the material use? Metals or glass or plastics? On the other hand, if it is a transport package, you again consider the size, weight and number of units and what kind of material.

Is it going to be a wooden case or a crate? Is it going to be a sack, metal or glass? So, depending on all these marketing considerations, you need to design the product. And the last is the convenience of use. As we already said, for primary packaging material you have to consider if it is going to be easy for opening. Is it having extra facilities of a reclosure? Will it have a dispensing aid? Does it need to have special functions like a spray or cook-in-pack, squeeze use or easy grip and how is the disposal going to be? All these have to be put in mind. In transfer packages for convenience, you need to consider again the size, the shape and after use.

What are you going to do with the tertiary packaging material after use? So now we have gone through four or three different factors. One is the product assessment, another was the hazard during distribution, the third is the marketing requirements and the last was the machinery consideration. Now in machinery consideration you should decide whether the packaging material can be handled in the existing machinery or do you need to purchase extra machinery for this particular design. Another thing you should keep in mind is the degree of skill required by the packaging line operator is also very important if it requires specialized skill. The size and shape of the package is also important when you are considering the machinery considerations.

So, when you are selecting a packaging system, I have highlighted some of the main important factors. One is the production method, display requirements, economic consideration, marketing need, product characteristics and the properties of the materials have to be considered while you are selecting the packaging material. Coming to the conclusion, from this journal on packaging technology, I have summarized the drivers to integrated packaging designers and the five drivers that will actually help in the designing is the first one is safety, then sustainability, marketing, logistics and economy. I have discussed this already.

Safety is you consider the safety of the contents and environmental safety. In sustainability, which is a very important factor when you design it, you have to see how sustainable is the product or the packaging material in relation to the environment, what are the cost factors that will be involved and what are the social dimensions that will be involved. Social dimensions include what are the ease of recyclability activities, what are the hygiene and safety standards that can be followed and coming to marketing. In marketing, you will require the product to be projected by the packaging material. Marketing information should be there. You should always consider the competitors, product and packaging while you are doing the marketing requirements.

Logistics, another very important factor where you will consider the hazards during

distribution, what is happening during transportation, storage and duration of storage that you will be having. Economy is another factor which includes the design of the package and the convenience that it's going to give to the consumer. So, with that, we have discussed the designing of the packaging material and what are the factors that you should consider while you are designing it. So, with that, we have concluded the designing of the packaging materials.

In the next session, we will continue with the testing of packaging materials. There are a number of tests that are done in the packaging materials and these will be discussed with videos in the next session. Thank you.