

Food Packaging Technology
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Introduction to packaging system

Welcome to NPTEL course. In this course, we will discuss Food Packaging Technology. In today's session, we are going to discuss about Food Packaging System. And in the coming sessions, we will also be discussing about product characteristics and packaging requirements, different forms of packaging, rigid, semi-rigid and flexible forms of packaging and different packaging systems for different foods. Now, let us understand what is a system. A system as per the dictionary, it is a set of principles or procedures according to which something is done, an organized framework of method, a group of devices forming a network specially for serving a common purpose, example, a packaging system.

In a packaging system, it is not only the packages that is important, it is also the network which is involved in it so that a package can be developed. That is also very important. In the earlier years, packaging was concentrating only on protection and preserving the goods inside. If it is a food, then food needs to be protected, its nutritional qualities need to be retained and also the shelf life need to be increased. That was the main idea of having a package in early years and it also concentrated on the handling, transport and storage of the products.

But recently or nowadays, the packaging has other functions also. It is taking care of sales promotion, customer attention and brand communication. So, these three parameters have also been added and now it has become a wide area. It has become a proper science which is concentrating on many aspects of the industry and it is correlated. And it is not just one function that needs to be met, it is a total of many functions. In simple words, a packaging developer who makes a package, he needs to design it as per the demand from the sales perspective and also from the marketing perspective. It is not only the manufacturing process and transportation, but also how well it can enter into the market and how long it can be remaining in the market. That also need to be taken care of by the package developer.

European Federation defines packaging as all products made of any materials of any nature to be used for the containment, protection, delivery and presentation of goods from

raw materials to process food. So, it is not only the goods or the finished products that need to be packed, it is also the raw material that need to be packed. Again, the four main functions of a packaging are containment, protection, delivery and presentation which we had already seen in the previous sessions. It stays strong here also and even European Federation has put more emphasis on these terms. And packaging is built as a system and it consists of three levels.

It can go up to fourth or fifth level. It depends upon how many packages are there. So primary packaging, secondary and tertiary packaging levels, that these are the most common ones and primary package, it concerns the structural nature of the package. And it's usually the smallest unit of distribution or use and is the package in direct contact with the contents. So, if you take a canned food, then can will be the primary package that comes in direct contact with the food and also it is the can which reaches to the consumer.

It is the smallest unit or smallest package that is reaching to the consumer. It is the primary packaging. And now secondary package, it is a visual communication. It gives the idea of the package and it groups all the primary packages together. Now primary package and secondary package both give information, they communicate to the consumer, they pass information to the consumer about the products.

And it is important in B2B transactions. And finally, it's tertiary package. Tertiary packages are important in warehouse where storage happens and also during transportation. So, these are general levels of packaging, but after tertiary packaging, we may have quaternary and also the fifth level. Now if you look at the figure here, it is the quaternary and tertiary packaging containers.

In the first figure, it is the primary package which is directly in contact with the food and many primary packages they are put together. There is a carton which protects this primary package. That is a secondary packaging and all secondary packages they are put over one tray and you can put a shrink wrap or something and so it becomes a tertiary packaging. Now if the same thing it goes to the container, then it becomes a fourth level. Same thing has been represented again. It's a raw material, the raw material is water, it is packed in bottles. So, that is the primary packaging and many bottles they are shrink wrapped and it becomes secondary packaging. This shrink wrap bottles these are packed in a carton. So, it becomes a tertiary package and then tertiary package they are palletized, many cartons they are palletized, they are put on a crate and it becomes a quaternary and then in a container it becomes quaternary.

Now packaging system is cross-functional since it interacts with different industrial

departments with their specific requests of how packages should be designed. It is not the producer who designs or manufactures the package, it is also the consumer or the intermediate levels and each section of the industry, they have a voice in package. So, everybody's opinion needs to be considered while designing a packaging. And packaging it has to satisfy several purposes. First one, physical protection that is the main very important objective and the objects enclosed inside the package it needs to be protected from mechanical shock, vibration, this electrostatic discharge, compression, temperature.

These are some of the external parameters that a package can undergo during transportation or it can undergo during storage. So, from there it needs to be protected. So that is the physical protection is very important. And second objective of the package is to provide hygiene. So, it should be a barrier to gases, water vapor, dust and nothing should accumulate on the surface of the container or the primary packaging so that also need to be taken care of or nothing should go into the food and also it should be clean, fresh, sterile and safe and because these are intended for extended shelf life, the product need to have a longer shelf life with minimum nutritional loss.

So, therefore, it should be safe and sterile. Now containment we had seen earlier, the container, it contains the products or small objects are grouped together in one package for efficiency reasons. For example, put the food into a container, it can be put anywhere, but container it limits and you can put many such containers together. So, it shows the efficiency of the container where so much product can be put. But if you use a larger container, you can contain the same amount of product, but then it will occupy large space.

So, containment and the use of container, what kind of container is being used that is also very important. Now most important one is information transmission. If the package should be able to communicate the information to the consumer. So, just by looking at it, consumer should know what are the contents, how long it is safe, how long it can be stored, how to use it because many of the packages you will find there are instructions how to use or how to cook. So, such kind of information needs to be packed and what are the methods to recycle it or dispose the package that also need to be given on the label.

Labeling is very important. In marketing, packages are also used by marketers to encourage potential buyers to purchase a product. That is another aspect of packaging. And the last one is security. Packages, there is to reduce the risk associated with shipment.

Many producers or many organizations they put electronic devices like RFID onto the

package for a real time tracking and this will reduce the risk of thefts and increase the security. This is also a very important aspect of packaging. Now packaging system cannot be separated from operations management, it has to go along with it. And clients now they realize that packages can be a central and critical element of development of an effective brand identity. Like I said in one of my classes, we have Maggi which has its own unique color code and packaging system.

That is the one which drives us to purchase the Maggi. If we find the same color and same type of design, though we take that one, we'll again look at the label. To make the brand effective, some color codes or some particular designs may be needed. And that is mainly because of the package because that is what we are seeing first. It's not the content inside.

And just by looking at the packaging system, we go for that particular product. And it is very important in operations management. So, it assumes a very fundamental role along the whole supply chain that in connects logistics, marketing, production, environment. So, you cannot separate it from any of these things. It is interconnected with all these parameters.

Now if you look at the figure here, packaging has the functions of containment, protection, convenience, communication, and unitization, but it is also connected with production. So, we have to know what you're going to produce and what form it is and how it has to be marketed. Based on that only the packaging material will be selected. We cannot have the same packaging material for meat or for the fruits or for a cereal.

So it will be different. Similarly, marketing, how to promote it, what is the value of the product. You can have a good thing, but if packaging is poor, nobody is going to buy it. So, if the content is good and if you have good packaging, then marketing will be easier. And then we have logistics, how you can handle it. So how can you transport it? Can you bring down the cost of the product by making it lighter or making it economical? Can you store it properly so that space can be utilized and distribution can be easier? So that kind of logistics also need to be taken into consideration.

And finally, but most important one is environment. Now we are also concentrating on the environment. What is the impact of packaging materials on the environment? Can it be reused? And if you dispose it, it should not increase the carbon content in the environment. Nowadays, it is a part of their agenda that the packaging materials what they are supplying need to be reused and it should be eco-friendly. It is very important that packaging has to consider this point also.

Now logistics, easy handling through all processes and for customers. Marketing; it

should look nice, right size, and not only presents the product to the shelf, but also it should arouse curiosity in consumers. The consumers, they should be curious to know what the product is, what is inside the package, and it should also reassure the quality and make confidence in consumer. Only then the consumer will come and buy the product next time. So that also is done by the packaging material.

And production, one size packaging, if we had different sizes of packaging, then it's difficult to handle. So, we should have one type of packaging because it will save labour, cost and time, and also the environment aspect which we had already seen. According to Johansson, packaging systems can be divided into three main functions, flow market and environment. Of course, environment, again, it is unavoidable, we cannot avoid this thing. Flow function, it consists of packaging features that contribute to efficient handling in distribution.

It includes packaging logistics, internal material flows, distribution, unpacking, disposal, return handling and also included in this under flow function. And packaging logistics, it is a new discipline and has gained a lot of attention in recent years. Now a lot of studies are being done and people are taking a lot of interest in this area. And Chan et al, in 2006, he described packaging logistics as the interaction and relationship between logistics and packaging system that improve add on values on the whole supply chain from raw material, producers to end users and the disposal of the empty package by reuse, material recycling, incineration or landfill. So, all these aspects of packaging are addressed in packaging system or packaging logistics.

In short, it improves the efficiency of the whole supply chain. So, it also improves the management of operations and it facilitates the goods handling. This is done by volume efficiency, consumption adaption, weight efficiency and handleability. Volume efficiency, it is a function of packaging design and production. So what product is accordingly, we have to have the package.

If you have a small product and you have a large package, then this is going to take a lot of space. So according to the shape, internal shape of the product or internal volume of the product, we have to choose a package so that there will not be any wastage of space, wastage of packages and it will be efficient packaging. Also, how well it can fit with the adjacent boxes or adjacent containers or adjacent packaging system. If that is also efficient, then we have met the volume efficiency. It is not only the content inside, it is also how well it fits with the other container, other packaging material and this will eliminate the risk during transportation or any shocks or anything that can happen during transportation or handling so that we can remove.

Then consumption adaptation, it is the quantity of package that must be adapted to the conception in order to keep costs low, not to tie unnecessary capital. Now if you have a product, if you have a chocolate for example that costs only 1 rupee or 2 rupees and you have a package that costs 15 rupees, then I will not be ready to buy the product that costs 15 rupees or 17 rupees because product inside costs only 2 rupees. So, you have to give up the package which suits to the package product, the cost and it should not be too much. So, it should be adapted or it should be according to the product inside. So, this will reduce the cost of the packaging.

Then weight efficiency, the package must have lowest possible weight because volume and weight limit, the possible amount of transport. So lighter containers are more preferred and that is why we have aluminium cans now and flexible materials are also getting promoted. The weight of the can or volume of the can is very important during transportation. So, if weight is too high, then transportation costs will also increase.

So we have to go for a lighter material. And also, while it reaches to the consumer, if the weight is too heavy, the consumer may not find it very easy to handle. So, from the consumer perspective also we have to think. Then handle ability of packaging, how easily it can be handled by the producer, by the consumer. On the producer's side it can be automatic, but when it reaches to the consumer, they are handling it manually. So how easily it can be handled that also need to be addressed.

And the second point of the packaging is identity to the product. We should be able to trace the product, the packaging system able to give an identity to the product. For example, the same example what we had been talking about, Maggie and the package it gives the identity to the product. And also, we should be able to trace it by installing some real time devices and then protect the product. Of course, that is the main function of the packaging system.

It has to protect the package, both in company as well as till it reaches to the user. So, it protects the product in the company that is within the factory, within in the warehouse and during transportation till it reaches to the consumer. So, in the market function, design, layout, communication, ergonomic aspects, all these things have to be put together so that product value can be increased and these needed to be branded. So, and these are very important features of packaging system. Now market function it concentrates on satisfying consumer and increasing the product sales.

Packaging was studied as a marketing instrument that influenced some specific aspects such as product positioning, consumer attention, categorization, evaluation, usage behavior, intention to purchase and brand communication. So, it is like you have a liquid

oil, so it has to be put in the oil category. So, packaging helps in doing that. It helps if you have a good covering, good package, then the consumer will be tempted to buy that. At least the consumer will be tempted to look at the product and at least go through the label and other things.

All these features need to be covered by the packaging and it is an interface between the brand owner and the consumer. So, owner of the company, if he is launching a brand, it reaches to the consumer and consumer just by looking at the package, he will understand the brand of the product and it gives an initial impression of the product quality. You cannot have a poor package for a product. Consumer will never look at the product. So, if it is a good product, then it should have a good package.

That is the first impression that a consumer gets and that is the point where they are judging the product. Now product packaging system in whole, it enhances the productivity within the company, within the factory and when it reaches to the consumer, it enhances the marketing. Now coming to the food packaging system, food packaging system is equally important as food. We cannot say it is one step less or one step more, it is equally important. So, what all importance are given to food to improve its nutritional quality or to preserve its nutritional quality or extend its shelf life, same kind of attention need to be given to food packaging system also.

So it should have high standards of quality and safety and also it should meet the requirements of governmental regulations and policies. Also, it is becoming very influential in influencing the consumer decisions. By changing the packaging, we can change the decision of consumers, we can drive them to purchase a particular product. So that is also very important.

Now these are different types of products. You can see here different types of packaging materials are there. One such product that is packed here is Muthiladu and Muthiladu will get in any shop just by looking at the package, you will be curious about the contents and so you will try to go and buy it. And if you buy this product, it should be able to retain it, it should make you confident to buy it next time also. So that should be the package. Now a field of food packaging, it compasses of a variety of aspects including food selection, labeling, designing of packaging materials, storage, transportation and distribution.

It is entire food product lifecycle. Production of food or food is developed till it is consumed, till it is utilized, the entire process or entire lifecycle of food packaging is important, it goes along with the food. So, understanding the interactions among these elements is key to food packaging. Engineers who help in delivering optimized

packaging systems to both manufacturers and consumers and it should be cost effective, convenient, it should protect the content and it should improve the market and sales. Now we had already seen different types of packaging materials.

We had discussed about glass, metal, plastics and paper board. So, you can also see the advantages and disadvantages and the barrier properties and the type of food where they are used generally. Plus, you find its applications in packaging, jellies, sauces, metal, preserves, juices, fish, plastic, water, bread and paper board in milk, cookies, eggs, etc. Now a lot of innovations are being done in the packaging design and materials and these are increasing day by day. This is because of the consumer preferences, consumers demand is increasing and COVID has also added to it, people are more tempted to buy packed products and regulations are coming up. Also, interest is being given to reduce the waste so that it doesn't influence or affect the environment.

Waste generated from the packaging industry, how you utilize or how easily we can dispose it that is also very important and it should not affect the environment. So, these criteria have promoted new innovations in this area and along with the visible information what packaging is giving, it is also giving services behind the scenes. There is information behind the, if you need anything you just have to call the customer care, they will provide information. So, anything regarding the food, that kind of services are also being encouraged and so ultimate aim of package is to serve a specific service with the goal of delivering a product safely and intact from manufacturer to user and in between it covers all these ideas.

So, these are some of the packaging materials. This is cardboard packaging. This looks elegant and good and it's easy to dispose, it is environment friendly. Then we have other eco-friendly and sustainable packaging materials like baguette case, collapsible cups, we have bamboo cutleries and reusable lunch bags. Then customized packing, it is another aspect of packaging itself, like it is branded and it is customized so we will know from which shop or who is selling this product that helps in promoting the product.

So, customized packing is also coming up. One of the most important things is food labeling and, in the label, we have to concentrate about the content. First part is what the product is, so that to be given in the label. Then what are the nutritional facts of this product, what are the ingredients, how long it can be kept, how it can be processed, how it can be cooked. So, such kind of instructions need to be given and therefore food label is also very important and more and more details are being given on the label. And when we go to packaging system, product characteristics also play a very important role and it is something which we cannot avoid or neglect and the factors that influence the packaging system or what kind of package we have to include depends upon various

factors.

One is product weight, what is the weight of the product that is going to be packed. So accordingly, whether the packaging material can it withstand this much weight. That need to be taken care. Then fragility, are we going to pack a product, a bottle or something that will break during transportation or handling. So accordingly, the package needs to be changed. Then spoilage considerations, does it need to have low vapor barrier or high-water vapor barrier or high gas barrier.

If it has low oxygen barrier to oxygen and the product inside is any fatty food, it may get rancid. So again, it may get spoiled. Then stacking strength, how many containers or how many packs can be loaded one above another. Then what is the temperature and what is the impact of temperature and environment on the package and the content inside and what kind of transportation medium method is going to be. Because the transportation by road, by rail, by flight differs and accordingly the packaging needs to be changed.

Now this is the packaging system. We have product inside which and the first material that comes in contact with the food is primary packaging and many such primary packages they are put together to form secondary packaging and many secondary packages they are put together to form tertiary packaging and tertiary packaging package they protect the contents inside. That is the main idea. Each packaging material, each layer, it protects the content inside from all the impacts. So, these complexities they go into the ultimate design of the system and sustainability outcomes need to be included in the design flow to assess the impact of delivering the product. In order to improve the system, one must be able to quantify the implications of everything that goes into making the item.

We should not go with the qualitative values. Quantitative values are important because if we say that this is the weight of the product we need to have the quantity. We cannot roughly say this will be the approximate quantity or this will be the approximate temperature. So, we have to exact give the exact details and this includes glass, metal, paper, plastic, wood, the processes needed for to make packaging, other components and overall implications of transportation. So, all these things need to be taken in care of during the development of a packaging system.

Now this is a slide which shows how the packages are done. Here if you look at the conveyor here, this is the individual product. It is a primary product. Many such primary products they are shrink wrapped so it becomes secondary packaging and then many second this product they are put in container of cartons. So, it becomes a tertiary

packaging and then is sealed here and many such cartons they are put over cart so it becomes the fourth level of packaging and then it is wound together so it becomes the fifth level of packaging. So, this is how the packaging system need to be maintained and it has to be validated and verified at each level of the system.

So, with this we have come to the end of this class and we have seen different aspects of packaging system. What is the packaging system and what is the significance of packaging system? In the next class, we will be discussing about the product characteristics and how it is important to choose a package. Thank you.