

Modern Food Packaging Technologies: Regulatory Aspects and Global Trends

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Welcome to the NPTEL online certification course on Modern Food Packaging Technologies: Regulatory Aspects and Global Trends. Dear friends in the last lecture we have seen changes and variations in packaging industries. In the present lecture, we will be discussing about the recent trends in packaging materials and we will be deliberating about the biodegradable and compostable materials. The topics which we will be covering is introduction, what is biodegradable packaging, biodegradable versus compostable packaging, types of biodegradable packaging materials, process of making biodegradable packaging, types of biodegradable packaging, steps for business start choosing and using biodegradable packaging, benefits of businesses using biodegradable packaging. Now, the introduction, the vast majority of packaging materials have long been made from plastics and this reliance on synthetic polymers has led to serious ecological problems. Plastics are major pollutants and it can take up 1000 years for plastic to biodegrade. This adverse environmental impact and increasing awareness about the importance of sustainable packaging are pushing brands and customers to adopt biodegradable packaging materials.

Research by McKinsey shows that 55 percent of consumers are concerned about the environmental impacts of packaging and 75 percent buyers would pay more for sustainable packaging. Adopting biodegradable and recyclable packaging materials by customers show that the business is environmentally responsible. In this class, we will explore the ins and outs of biodegradable packaging and how to select the right packaging solutions for any business. What is biodegradable packaging? Biodegradable packaging is commonly thought to be made only from the bio based plant based materials, but the truth is that is not true.

Biodegradability depends upon the molecular structure and strength of materials polymer chain rather than its source. To biodegradable, the polymer structure, string and

monomers that make up the material must be able to disintegrate or breakdown into tiny pieces that can be safely digested by microorganisms. This means biodegradable packaging can be made from bio based and fossil based polymers. What is biodegradable packaging? It is any packaging that will naturally breakdown from microorganisms such as bacteria, fungi and algae within a short period of period following disposal usually a year or less. This means that the packaging will breakdown quicker.

Biodegradable plastics can breakdown into micro plastics which are smaller fragments of plastics. Micro plastics are thought to be damaging if they end up in the ocean although they are thought to be a better greener alternative to plastic. If something is biodegradable given the right conditions and the presence of bacteria, fungi or microorganisms it will eventually breakdown to its basic components and blend back into the earth. These substances should degrade without leaving any toxins behind although this is not always the case. For example, when a plant based product breaks down into carbon dioxide, water and other naturally occurring minerals the substance mixes back into the earth leaving no toxin behind.

However, many materials even those with a biodegradable level breakdown to a more harmful manner. This can leave chemicals and other damaging substances in the soil. The best biodegradable materials will breakdown quickly rather than taking years. They should leave nothing harmful behind and save landfill space. Not everything that is advertised as biodegradable meets this criteria.

If someone is running a green business he should ensure things are accurately labeled and should make sure to ensure that the materials being used are effectively and safely biodegradable. The biodegradable versus compostable packaging. The biodegradable products that breakdown naturally into organic materials in an undefined, but reasonable amount of time. Whereas, compostable materials the products that breakdown to biomass at the same rate as other organics like plants and leave no residue after roughly 3 months. The biodegradable no human invention needed the action of naturally occurring microorganisms such as bacteria, fungi and algae whereas, in the compostable material human intervention needed the capable of breaking down in a compost environment that is worms compost bins.

The biodegradable materials takes less time than the thousands of year needed for some plastics to breakdown. Whereas, the compostive process usually takes only about 90 days. The biodegradable sometimes leave behind metal residues whereas, the compostable materials leave no distinguishable, visible or toxic residues. The benefits of biodegradable material is that compared to non biodegradable they do not require any use of chemicals or decomposition which is less environmentally damaging. And the compostable materials benefit is their end products provide nutrient to soil and they have the least environmental impact.

The problems associated with biodegradable materials are the temperatures and oxygen needed to induce biodegradation may not be reached in the landfill. And there are no industry standards for what is and is not considered biodegradable. And the problems associated with compostable materials is lose that they lose value if they end up in a landfill. They have no biodegrade in a municipal or industrial composting facilities which most cities do not yet have. Types of biodegradable packaging materials.

Biodegradable packaging materials are now more popular among brands and consumers. The market for biodegradable plastic packaging was assessed 4.65 billion US dollars in 2019 and is anticipated to increase at a compound annual growth rate of 17.4 percent by 2025 reaching a market value of 12.06 million US dollar.

Because of the surge in demand more companies are switching to sustainable packaging and using biodegradable packaging materials here are some of the top materials used today. The corn starch Derived from the corn to maize plant. Corn starch possesses plastic like characteristics that make it a good plastic substitute in various applications including bottles and other molded shapes and loose film packaging. Companies favor this biodegradable packaging since the raw material is affordable, easy to produce and sustainable. Corn starch based packaging will decompose into carbon dioxide and water if disposed of properly over several months.

The mushrooms To produce mushroom packaging agricultural waste is cleaned, powdered and joined together by a matrix of mushroom roots also called mycelium. Desired shapes can be created using these basic materials. After drying it is used as eco friendly food packaging among other forms of packaging and in only a few days fungus

fibers tie the trash together to form a solid shape that dries and prevents further growth. Seaweed Agar a substance in many kinds of seaweeds and algae is used to make seaweed packaging. It is frozen to form a rigid film like a state that is then squeezed to create a soft cushioning agent.

Because seaweed is a great sustainable raw material, seaweed packaging is a very appealing and environmentally beneficial packaging choice. It biodegrades in the soil in 4 to 6 weeks and is also an effective way to lessen ocean acidity. Cellulose The cellulose film packaging is biodegradable packaging made from wood or cotton. It minimizes trash generation and offer superior printability and durability. During a projected period the availability of different inventive packaging solutions will likely positively impact the demand for cellulose film packaging.

On average uncoated cellulose film decomposes in 28 to 60 days when buried or composted while coated cellulose decomposition last between 80 to 120 days. Paper and cardboard are 100 percent biodegradable and pose a popular plastic alternative when it comes to packaging. These flexible materials are useful for packaging storing and transporting items. Paper is a sustainable resource since it biodegrades in 2 to 6 weeks and may be recycled up to 6 times before the fiber becomes too short. The process of making biodegradable packaging

Eco-friendly packaging can be made easily and affordably whatever type of business person you are. The main phases in creating eco-friendly packaging are listed below to assist you in grasping a green way. Choose the packaging material. The pick packaging materials that reflect your brand choices you can select from recycled plastic, paper, cloth or glass as many recyclable materials are available on the market. Now collect raw materials.

The extraction process of industrial raw materials includes a variety of phases and procedures such as breaking, shifting or grinding. One can collect raw materials from drop off locations or recycling units. After gathering one might transport the materials to a manufacturing facility where they would be stored, cleaned and prepared for production. For this step specialized machines are implied to extract minerals and raw

materials and process, transport and store the goods. There are also methods for materials eventual treatment.

Accelerated solvent extraction is an example of how packaging samples are tested. The manufacture of packaging. Sustainable manufacturing practices such as switching from fossil fuel power to renewable energy during production are equally important for producing eco-friendly packaging. In contrast to fossil fuels, renewable energy is sourced naturally by the sun, wind, biomass or rain. One can lower his business carbon footprint by using environmentally friendly energy sources for packaging production.

As part of the manufacturing process reducing packaging waste output and conserving water are crucial. Labels the packaging Inks can be detrimental to the environment since they include several chemicals. Several green manufacturers have switched from conventional ink solvents to more environmentally friendly versions of low volatile organic compounds. Other volatile organic compounds free eco-friendly inks containing only water, acetone or ethanol are great options. The great thing about biodegradable packaging is that after its use the packaging goes back to the earth.

Then the cycle for packaging production starts again. Now, the types of biodegradable packaging. Corrugated boxes. Corrugated boxes are one of the most common biodegradable packaging available. Untreated corrugated boxes will soften and crack when exposed to water and eventually decomposed completely.

If corrugated boxes are not contaminated by external substances such as oil, stains or chemicals they can be used repeatedly and recycled to make new boxes. However, since paper is derived from wood it is important to observe whether the boxes are produced using sustainable trees. Bagasse bags. Bagasse bags are a biodegradable packaging that can be composted at home. The light and waterproof bags are made from the leftover plant fiber after sugar cane has been squeezed.

The food grade raw material is suitable for packaging food and kitchen waste after use it can be directly buried in the soil as compost. The craft paper bags. Craft paper bags are produced with paper pulp. Since craft paper bags are neither waterproof nor oil proof they are mainly used for packaging bread, letters and clothes. The non-toxic odorless

non-polluting bags offer a high quality texture making them suitable for the retail industry.

However, some craft paper bags are laminated with petroleum based polypropylene plastic films to become waterproof these plastic laminated craft paper bags are not biodegradable. Meanwhile the raw material of pulp is wood thus sustainable forest sources should also be considered. Polylactide bags. The main ingredient of polylactide or PLA bags is corn starch. PLA bags have properties similar to conventional plastic bags with advantages including matured technology and inexpensiveness.

However, because they are not resistant to heat and light PLA bags are not suitable for direct packaging in factories and are mainly used as shopping bags, bread bags, magazine bags and so on. Bagasse food containers. Bagasse food containers are made from bagasse which is waterproof and oil resistant without the need of additional chemical lamination. The product does not contain chemicals such as PFS that is the per and polyfluorinated substances, fluorescent agents and bleaching agents. Thus it can be used for holding food such as steak, potato chips, pasta and burgers.

Bagasse food containers can also hold fresh vegetables, fruits and meat. After use simply bury them in the soil for composting at home and there is no need to consume water to clean the containers. The edible seaweed film. Edible seaweed film is produced with sodium alginate and natural thickener in seaweed which can be used to hold liquid in the form of a sphere. When drinking the beverage the film can also be ingested making it natural and safe.

Since the seaweed is edible the film will break down naturally within a few days as it is usually used for packaging beverages at special events. The bagasse cups. Bagasse cups can replace disposable plastic caps or paper cups and they can be reused after cleaning. Made from bagasse and agricultural waste the cups can withstand heat up to 90 degree Celsius perfect for holding coffee tea and water. After approximately 1 year in use the cups will start become brittle and disintegrate, decomposing and storing carbon dioxide in the soil when buried.

The burlap sacks. Burlap sacks are woven from jute a natural fiber. After use they can be buried in the soil by the roots of newly planted trees to provide a good air permeable

drainage layer producing organic matter and bacteria to allow the sacks to gradually decompose. Burlap sacks can be used to hold rice, wheat flour, coffee beans and so on and they can also serve as shopping bags or backpacks. Biodegradable packaging peanuts. Packing peanuts are small and compressible able to penetrate the gaps of the packaging to protect and hold the product and absorb shocks.

Traditional packaging peanuts are made of low density polystyrene which is difficult to recycle. Carbon based biodegradable packaging peanuts are instead made of starch which will melt in water in just a few minutes making them harmless to the environment and even indigestible by organisms. The product can be used as a cushion for electronic components. Bagasse egg cartons. Due to bacterial residue on the surface of eggs, egg cartons cannot be reused.

Bagasse egg cartons are durable and after a certain degree of cushioning. After use they can be buried in the soil to decompose. Mycelium boxes. Mycelium boxes utilize mushroom roots as a bio adhesive. When combined with other biodegradable materials such as hemp shells, the boxes offer a considerable thickness that can cushion and protect products by absorbing shock.

Also biodegradable after use the boxes are mainly used for glass bottle packaging, shoe boxes and other purposes. The benefits of biodegradable packaging. It reduce pollution costs, it reduce production cost, it is non-toxic and allergen free, it boosts brands image, it reduces carbon footprint and it increases sales. The steps for business start choosing the using biodegradable packaging. There are five steps for businesses start choosing and using biodegradable packaging.

The first one is inventory. All packaging currently used by enterprise by counting the number of various packages used. Second, confirmation of suitability of biodegradable packaging. The products are ingredients suitable for alternative packaging with shorter shelf life. The third one is to choose suitable biodegradable packaging. By choosing packaging that complies with local recycling maker.

The fourth one is formulate a plan to introduce biodegradable packaging that gradually increase the proportion of biodegradable packaging. Document and disclose the amount

of packaging used. The increase bank credibility with data. An inventory of various types of packaging currently used by enterprises.

From procurement, production and manufacturing to shipping, enterprises require different types of packaging. So taking an inventory of packaging materials currently used is the first step. For instance, a coffee house selling deserts may use packaging such as coffee bean bags, flour bags, vegetable and fruit packaging bags, chocolate bags, butter bags, cake boxes, paper coffee cups and shopping bags. Confirm whether it can be suitably replaced with biodegradable packaging. After confirming the packaging currently used, individually check whether it can be suitably replaced with biodegradable packaging.

For instance, vegetable and fruit packaging bags will be placed in the fridge together with cake decoration fruits thus biodegradable packaging bags are suitable here. Choose suitable biodegradable packaging. After confirming the suitability of biodegradable packaging, the type of biodegradable packaging can be chosen based on the level of eco-friendliness and budget. For example, if there are industrial composting facilities and waste disposal systems needed near the sale site, PLA packaging is suitable. Otherwise bagasse packaging that can be composted at home should be used.

Furthermore, the safety durability and aesthetics of the packaging must be taken into consideration. Formulate a plan to introduce biodegradable packaging. After selecting biodegradable packaging, formulate a plan to progressively implement it. For instance, in regards to health oriented cakes, new biodegradable cake boxes can be used. When purchasing from a fruit supplier, ask for biodegradable packaging or switch to fruit suppliers who use biodegradable packaging thereby gradually increasing the ratio of biodegradable packaging until all the items in all categories are using biodegradable packaging.

Document and disclose the amount of packaging used. Enterprises can document the amount of biodegradable packaging before and after introducing the plan and disclose such information to their stakeholders and consumers. In doing so, they can increase the credibility of that brand and ensure enterprises continue to use biodegradable packaging. The benefits of businesses using biodegradable packaging. There are six benefits of

businesses using biodegradable packaging that are create a good corporate image that allows consumers to understand the environmental protection image of the company through direct consumption experience. The increase the ratio of industrial waste properly disposed of to meet the local regulatory agency requirements.

The lower greenhouse gas emissions. Biodegradable packages has lower carbon emissions than petrochemical plastic packaging. Increase corporate ESG ratings, can improve waste and greenhouse treatments, two keys indicators that affect ESG scores. The ESG scores less than 50 is poor and ESG score more than 70 is good. Add value to products and brands. Consumers are willing to pay more for sustainable products which also makes the products more unique. And the lastly create a sustainable supply chain to avoid future inability to use existing packaging due to raw material depletion or regulatory constraints. Thank you very much.