Sustainable Food Packaging Options

EXTENSION

August 2021

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Introduction

According to a market survey conducted by Mintel Group Ltd., only a very small percentage of the consumers are making purchasing decisions based on the food packaging, However, they value freshness and convenience, which may be related to packaging.

Containment, protection, communication and convenience are the most important functions of food packaging. Although food containers made of glass, plastic, metal and paper all meet the criteria for containment, each material has a unique set of properties that determine their suitability for a given product. For example, paper is not the best choice for the foods that need to be thermally processed in the package or those that have a high moisture content. Glass provides absolute protection of foods from gasses, water vapor and external aromas/odors, but lacks protection from light for light-sensitive products.

Labels on the packages communicate both marketing and legally required information about the product to consumers. Convenience is an important consideration for packaging design. Ease of opening the package, dispensing the product and resealing the package are some of the design criteria driving the innovations in the field.

Changes in shopping and eating habits also are affecting packaging design. For example, increasing online shopping requires packages that can withstand shipping conditions at retail sizes and help consumer easily differentiate the product among many similar ones appearing on the screen. Another example is the increasing consumer demand for prepared foods, leading to tray-shaped package design for convenience. Plastic has been the choice of material for food packaging as well as many other products for decades. More than one-third of the food manufacturers use plastic packaging. The growing plastic pollution is alarming and single-use plastic packaging is being labeled as the culprit for this growing problem. Fortunately, consumers have started to realize the damage caused by plastic waste and rethink their use and disposal habits of plastic items. Manufacturers are challenged by the consumer demands for sustainable, environmentally benign alternatives. About 25% of the consumers more than 18 years of age say they plan to purchase foods and drinks that come with minimal packaging within the next two years. As a response, waste- and package-free retail options are gaining popularity.

Road to Sustainability

Although consumers are concerned about environmental pollution, they think industry has to be the driver for change, and initiate and implement sustainable practices. Indeed, many companies, especially the ones with great marketing power, such as Walmart® and Amazon are adopting more environmentally benign practices. Many companies have already made commitments to make their plastic packaging entirely recyclable, reusable or compostable by the year 2025.

There is no question that making sustainable packaging choices is not an easy task. There are so many factors and questions to be evaluated while making the decision. "What is the carbon footprint, is compostable, reusable, recyclable, biodegradable and is more bio-content really better and would consumers be willing to absorb the associated higher cost of the sustainable packaging?" are some of the immediate questions that need to be answered. Reduced packaging, biodegradable packaging materials and recycling appear to be some of the popular practices adopted by the industry.

Reduced Packaging

A program called "Packaging Score Card" initiated by Walmart® is a good and effective way of reducing packaging waste and its adverse environmental impact. The program is based on a measurement tool derived from the "7 R's of Packaging": Remove, Reduce, Reuse, Recycle, Renew, Revenue and Read. The program allows suppliers to evaluate themselves relative to other suppliers. Each package is reviewed and scored. The packaging reduction metrics for the packaging scorecard are: 15% for greenhouse gases/CO_2 per ton of production, 15% for material value, 15% for product/package ratio, 15% for utilization, 10% based on transportation, 10% for recycled content, 10% for recovery value, 5% for renewable energy use and 5% based on innovation. The suppliers get an overall and a relative score in each category from Walmart® and they are encouraged to identify improvements and/or innovations that may reduce mass, cost and energy consumption, increase recycling rate or to employ renewable resources. Amazon gives the consumers two choices, receiving their purchases a few days earlier in regular packaging or delaying the receipt a couple days to get the item in reduced packaging.

Edible packaging is another approach to reduce packaging. Waxes, polishes, shellac, sugar and salt have all been used to coat foods to reduce moisture, oxygen, flavor gains or losses and enhance appearance of fruits and vegetables. Coatings also can be formulated with ingredients that repel insects, delay microbial growth and oxidation reactions. A lot of research is being performed on edible films, facilitating

formation of films on foods to provide some level of protection and to reduce the complexity and cost of conventional packaging, not necessarily completely eliminate the need for non-edible packaging.

Biodegradable packaging

Bio-based and biodegradable food packaging materials have been gaining increased attention due to public awareness of the environmental problems created by conventional plastic materials and consumer demand for sustainable industrial practices. Biodegradable packaging materials are designed to degrade by natural and biological means and dissipate after they perform their main function. During biodegradation assisted by microorganisms naturally present in the ground, the material decomposes to water, carbon dioxide, biomass and methane. Although the residual solid material may be beneficial to soil, produced carbon dioxide and methane are greenhouse gasses that contribute to climate change.

According to the European Bioplastic Organization, bioplastic is a plastic material that is either partly or fully derived from renewable resources like biomass or biodegradable or possesses both properties. Biopolymers used for food packaging are materials originating from agricultural and marine sources and can be divided in three categories: polymeric materials produced by chemical synthesis from bio-derived monomers; polymeric materials produced by microorganisms; and natural biopolymers extracted directly from raw materials.

Biodegradable Natural Polymers

Biodegradable natural polymers are derived from biomass and other agricultural sources. Polysaccharides, proteins of animal or plant origin, lipids and polyesters from microbial sources are some of the natural polymers used in food packaging applications. Water-soluble pouches made from polysaccharides are very good oxygen barriers and have been commercial for years. Although both polysaccharide and protein-based films are good barriers to gases, they are poor barriers against water vapor and have moderate mechanical strength limiting their use in many packaging applications.

Biodegradable Synthetic Polymers

As the name implies, biodegradable synthetic polymers are manufactured materials and, unlike their fossil-based counterparts, are biodegradable. They decompose through slow chemical hydrolysis in an aqueous environment that can be improved by enzymatic catalysis. Polyglycolic acid (PGA), polylactic acid (PLA), and their co-polymers polylactide-co-glycolide (PLGA) are some of the biodegradable synthetic materials being used in antimicrobial packaging applications.

PLA is one of the most promising bio-based polymers due to its availability, compostability, biocompatibility and having properties similar to fossil-based polymers. It is suitable for making flexible films, extruded packages, containers, bottles, cups and lunch boxes. PLA decomposition requires industrial composting at 55 C to 60 C. It has been approved as safe by the U.S. Food and Drug Administration (FDA). Unfortunately, its inferior barrier and mechanical properties when compared to the fossil based counterparts limit the use of PLA in many food packaging applications. However, it is possible to design and modify the properties of PLA by changing its chemical composition with additives.

Polyhydroxyalkanoates (PHA) are bio-based polyesters produced on renewable sources such as glucose through bacterial fermentation or from organic acids. Physicochemical properties of PHA are similar to conventional plastics and they are biodegradable in different environments. Biopol™, a commercial PHA product manufactured by Metabolix Inc. (USA) has been reported to have excellent film-forming and coating properties and is mainly used to produce disposable food containers and utensils. Mirel™ bioplastics, which also are made from PHA are suitable for wide ranging packaging applications, including hot and cold cups, cup lids, yogurt containers, tubs, trays and single-serve food packaging.

Polybutylene succinate (PBS) and its copolymers are a family of commercially available aliphatic polyesters with good biodegradability, compostability, moderate mechanical properties and good thermal and chemical durability. PBS has low impact strength and tear resistance which might limit its use in packaging application. However, PBS is suitable for making films and semi-rigid bowls. High crystallinity and good thermal properties of polybutylene succinate adipate (PBSA), a copolymer of PBS, makes it a suitable material for food packaging applications. GSPLA® (Mitsubishi Chemicals), Bionolle™ (Showa Denko K.K.), Skygreen (SK Chemicals), and BIOPBS™ (PTT MCC Biochem) are some of the commercial PBS- and PBSA-based materials.

Polyvinyl alcohol (PVA) is a synthetic biodegradable polymer that can be reused.

Plasticizers such as glycerol, polyethylene glycol, sorbitol, propylene glycol, ethylene glycol and lipids can be added to the biodegradable synthetic polymers to improve their flexibility and extensibility and even enhance the moisture sensitivity. However, plasticizers may adversely affect food aroma or increase oxygen permeability of the films.

Researchers also are working on photodegradable packaging materials, which decompose upon exposure to visible and/or ultraviolet radiation after fulfilling their functionality. However, photodegradable thermoplastic sheets and films developed so far have not yet proven to be satisfactory for many food packaging applications.

Recycling and Reuse

Replacement of single-use plastic packaging with durable, reusable packaging is one of the most popular practices adopted by food manufacturers and services. For example Mars Wrigley has a program called “the ORBIT® Mega Pack” which features an outer plastic package designed to be recycled in most of the U.S. recycling systems. The idea is to use How-2Recycle® which is a standardized labeling system that clearly communicates a step-by-step guide on whether and how to recycle each part of the pack. Following these guidelines, consumers can find out and act on how to reduce, reuse and recycle the best possible way in their local markets. Another example is the M&M®’s Choco 300g pouch, which uses only one type of plastic material to facilitate easy recycling within the existing local packaging waste collection and sorting system.

It is important to emphasize that recycling requires energy, water and the transport of materials. Most recycled plastics get shredded, melted and reformed into goods but eventually end up in a landfill after their useful second life.

The biggest challenge with recycling and reuse of packaging materials is the limited or complete lack of good

infrastructure for collecting, sorting and processing different types of material. Most of the plastic packaging materials are made from several different types of plastics. Sorting and recycling such materials are very difficult and costly.

Conclusions

Although significant advancements have been achieved in the development and marketing of biodegradable package materials and disposable utensils for fast food retailing, commercial adaptations have been limited. Relatively high cost and lack of infrastructure for easy efficient segregation of biodegradable packaging from non-degradable ones are the main bottlenecks for broad acceptance of these products and their economic viability.

It is important to emphasize that biodegradation and composting may produce greenhouse gasses and/or require controlled conditions adversely affecting environment and increasing processing costs. Identification or clear labeling of the recyclable and biodegradable materials as well as the consumers education are crucial if the sorting takes place at consumer level. Some argue that central sorting of municipal waste results in higher recycling rates than home sorting.

Biodegradable packaging materials might not abolish plastic pollution or decrease the amount of fossil-based plastics used in the short term but ongoing research and technological developments on biodegradable materials, process development for conversion of packaging materials made of different types of plastics to reusable forms, package design, investments in infrastructure for recycle and reuse of packaging materials and, most importantly, consumer education and demand for adaptation of ecologically responsible practices by industry and individuals could lead us closer to a more sustainable future.

The Oklahoma Cooperative Extension Service

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The Cooperative Extension Service is the largest, most successful informal educational organization in the world. It is a nationwide system funded and guided by a partnership of federal, state, and local governments that delivers information to help people help themselves through the land-grant university system.

Extension carries out programs in the broad categories of agriculture, natural resources and environment; family and consumer sciences; 4-H and other youth; and community resource development. Extension staff members live and work among the people they serve to help stimulate and educate Americans to plan ahead and cope with their problems.

Some characteristics of the Cooperative Extension system are:

- The federal, state, and local governments cooperatively share in its financial support and program direction.
- It is administered by the land-grant university as designated by the state legislature through an Extension director.
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- It provides practical, problem-oriented education for people of all ages. It is designated to take the knowledge of the university to those persons who do not or cannot participate in the formal classroom instruction of the university.
- It utilizes research from university, government, and other sources to help people make their own decisions.
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- It dispenses no funds to the public.
- It is not a regulatory agency, but it does inform people of regulations and of their options in meeting them.
- Local programs are developed and carried out in full recognition of national problems and goals.
- The Extension staff educates people through personal contacts, meetings, demonstrations, and the mass media.
- Extension has the built-in flexibility to adjust its programs and subject matter to meet new needs. Activities shift from year to year as citizen groups and Extension workers close to the problems advise changes.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director of Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. This publication is printed and issued by Oklahoma State University as authorized by the Vice President for Agricultural Programs and has been prepared and distributed at a cost of 20 cents per copy. August/2021 GH.