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Food packaging: Role, Materials and Environmental Issues

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ABSTRACT

The new and emerging technologies in food processing and packaging play a primary role in keeping food supply at the safest side. Packaging protects food from the external environment. Packaging technology must therefore balance food protection with the issues like energy and material costs, heightened social and environmental consciousness, and strict regulations on pollutants and disposal of municipal solid waste (MSW). MSW consists of items commonly thrown away, including packages, food scraps, yard trimmings, and durable items such as refrigerators and computers. It has been seen that food packaging is a noteworthy contributor to MSW because food is the only product class typically consumed three times per day by every person. Accordingly, food packaging accounts for almost two-thirds of total packaging waste by volume. In this regard EPA provides an overview of solid waste management guidelines and other waste management options, addresses disposal methods of and legislation on packaging disposal, and describes the current sustainable cradle-to -cradle concept, which replaces the cradle-to-grave emphasis.

I INTRODUCTION

1.1 Food Packaging: Roles and Materials

The principal roles of food packaging are to protect food products from outside environment, to contain the food and to provide consumers with ingredient and nutrition information. Traceability, convenience, and tamper indication are secondary functions of increasing importance. The goal of food packaging is to contain food in a cost effective way that satisfies industry requirements and consumer desires, maintains food safety, and minimizes environmental impact. Materials that have traditionally been used in food packaging include glass, metals, aluminum, foils and laminates, tinplate, and tin-free steel, paper and paperboards, and plastics. Today's food packages often combine several materials to exploit each material's functional or aesthetic properties.

1.2 Waste Management Approach

Waste management approach involving source reduction, recycling, composting, combustion, and landfilling. In order to protect the human health , environment and to preserve the natural resources it is important to go for proper waste management**.** EPA strives to motivate behavioral change in solid waste management through non regulatory approaches, including pay-as-you-throw

andWasteWise. In pay-as-you-throwsystems, residents are charged for MSW services on the basis of the amount of trash they discard. This creates an incentive to generate less trash and increase material recovery through recycling and composting. On average, communities

with pay-as-you-throw programs achieve waste reductions of 14% to 27% per year. WasteWise (launched in 1994) is a voluntary partnership between EPA and U.S. businesses, institutions, nonprofit organizations, and government agencies to prevent waste, promote recycling, and buy

recycled content products. More than 1800 organizations participated in the WasteWise program in 2005[1]. Moreover, the EPA Environmentally Preferable Purchasing program helps federal agencies and other organizations purchase products with lesser or reduced effects onhumanhealth and the environment as compared to other products that serve the same purpose. Pollution prevention is the primary focus, with a broader environmental scope than just waste reduction. EPA's guidelines for solid waste management [2] emphasize the use of a hierarchical, integrated manage

1.2.1 Source Reduction:

Source reduction encompasses using less packaging, designing products to last longer, and reusing products and materials [3]. Specific ways to achieve source reduction include using thinner gauges of packaging materials (i.e., lightweighting), purchasing durable goods, purchasing larger sizes (which use less packaging per unit volume) or refillable containers, and selecting nontoxic products**.**

1.2.2 Recycling

A typical recycling program entails collection, sorting and processing, manufacturing, and sale of recycled materials and products. EPA's Comprehensive Procurement Guidelines (CPG) promote the purchase of products made with recycled materials. EPA designates products that can be made with recovered materials and recommends practices for buying these products. After EPA designates a product, procuring agencies are required to purchase the product with the highest recovered material content level possible. EPA has selected more than 60 recycled content products under the CPG program and proposed several additional products Almost all packaging materials (glass, metal, thermoplastic, paper, and paperboard) are technically recyclable, but economics favor easily identified materials such as glass, metal, high-density polyethylene, and polyethylene terephthalate.

1.2.3 Composting:

It is controlled aerobic or biological degradation of organic materials, such as food and yard wastes. Accordingly, it involves arranging organic materials into piles and providing sufficient moisture for aerobic decomposition by microorganisms. Because organic materials make up a large component of total MSW (about 25% for food scraps and yard trimmings), composting is a valuable alternative to waste disposal.

1.2.4 Combustion

The controlled burning of waste in a designated facility, is an increasingly attractive alternative for waste that cannot be recycled or composted. Reducing MSW volume by 70% to 90%, combustion incinerators can be equipped to produce steam that can either provide heat or generate electricity (waste-to-energy combustors or WTE facilities). In fact, plastics are derived from petroleum feedstocks and possess a high heat content that is advantageous for waste-to-energy incineration. In 2004, the United States had 94 combustion facilities of which 89 wereWTE facilities, with a processing capacity of about 95000 tons per day or about 13% of MSW.

1.2.5 Landfilling

Landfilling provides environmentally sound disposal of any remaining MSW and the residues of recycling and combustion operations. The location and operation of landfills are governed by federal and state regulations, and today's landfills are carefully designed structures in which waste is isolated from the surrounding environment and groundwater. A properly designed MSW landfill manages leachate and collects landfill gases (methane and others) for potential use as an energy source. Having passed through or emerged from landfill waste, leachate contains soluble, suspended, or miscible materials from the waste. EPA is investigating a modification in landfill design known as a bioreactor that can enhance aerobic and/or anaerobic degradation of leachate and organic waste.

1.3 Other Disposal Methods

1.3.1 Anaerobic degradation

The main form of degradation that occurs in landfills is anaerobic degradation or digestion. In anaerobic degradation or digestion, microorganisms slowly break downsolid waste—primarily organic based materials such as wood and paper—(in the absence of oxygen) into primarily carbon dioxide, methane, and ammonia. Collecting and pumping leachate through the compacted solid waste can accelerate this process by inoculating the mass and providing a moisture source that promotes further degradation. To prevent groundwater contamination, leachate should be contained in a system, usually a combination of liners and storage systems. Ultimately, leachate is processed by a treatment facility to make a stable residue that can be disposed of safely. Anaerobic degradation is mostly used to treat biosolids (sewage sludge) and organic waste contaminants. More research is necessary to realize the full potential of anaerobic degradation in the management of solid waste.

1.3.2 Biodegradable polymers

Biodegradable polymers are derived from replenishable agricultural feedstocks, animal sources, marine food processing industry wastes, or microbial sources. In addition to renewable raw ingredients, biodegradable materials break down to produce environmentally friendly products such as carbon dioxide, water, and quality compost [4]. Biodegradable polymers made from cellulose and starches have been in existence for decades, with the 1st exhibition of a cellulosebased polymer (which initiated the plastic industry) occurring in 1862 [6] . Cellophane is the most common cellulose-based biopolymer. Starch-based polymers, which swell and deform when exposed to moisture, include amylose, hydroxylpropylated starch, and dextrin. Other starch-based polymers are polylactide, polyhydroxyalkanoate (PHA), polyhydroxybuterate (PHB),andacopolymerofPHBandvaleric acid (PHB/V).Madefrom lactic acid formedfrommicrobial fermentationof starchderivatives, polylactide does not degrade when exposed to moisture. PHA, PHB, and PHB/V are also formed by bacterial action on starches [7]. In addition, biodegradable films can also be produced from chitosan, which is derived from the chitin of crustacean and insect exoskeletons. Chitin is a biopolymer with a chemical structure similar to cellulose. Edible films, thin layers of edible materials applied to food as a coating or placedonor between food components, are another form of biodegradable polymer. They serve several purposes, including inhibiting the migration of moisture, gases, and aromas and improving the food’s mechanical integrity or handling characteristics. Edible films are derived from plant and animal sources such as zein (corn protein), whey (milk protein), collagen (constituent of skin, tendon, and connective tissue), and gelatin (product of partial hydrolysis of collagen).

Synthetic polymers can also be made partially degradable by blending them with biopolymers, incorporating biodegradable components (such as starches), or adding bioactive compounds.

The biocomponents are degraded to break the polymer into smaller components. Bioactive compounds work through various mechanisms. For example, they may be mixed with swelling agents, which expand the molecular structure of the plastic upon exposure to moisture to allow the bioactive compounds to break down the plastic. Arguments supporting the development of biodegradable polymers range from addressing problems of solid waste disposal and litter to substituting renewable resources (plant origin) for nonrenewable resources (oil, coal, and natural gas) as raw materials. Despite certain advantages, the use of biodegradable materials is not a solution to all solid waste management problems. A switch from synthetic polymers to biopolymers will have little impact on source reduction and incineration, but recycling could be complicated by the existence of blended or modified polymers unless they are separated from the recycling stream. Biodegradable plastics have little benefit in a landfill because landfills generally exclude the oxygen and moisture that are required for biodegradation. If biopolymers become widely used, it is questionable whether there will be sufficient plant materials to make sufficient quantities ofpackagingpolymers and whether optimizing crops for such polymers will interfere with food production. At this time, bioplastics are more expensive than most petroleum-based polymers, so substitution would likely result in increased packaging cost.

Even if biodegradable packaging is not practical on a broad basis, theadvantages are very significant for certain applications.The litter argument for biodegradable plastics has merit to the extent that biodegradable plastics will tend to break down and become less obtrusive after being littered. Biodegradability is important in the marine environment in which litter poses hazards to marine life.

Biodegradability can also be useful in military applications forwhich traditional disposal options are lacking. Specific but minor functions for biodegradable polymers include limiting moisture, aroma, and lipid migration between food components. Commercialization of bioplastics is underway.NatureWorks, LLC (a stand-alone company wholly owned by Cargill Inc.) manufactures polylactide from natural products (corn sugar). After the original use, the polymer can be hydrolyzed to recover lactic acid, thereby approaching the cradle-to-cradle objective (that is, imposing zero impact on future generations). In addition, Wal-Mart Inc. is using biopolymers by employing polylactide to package fresh cut produce [8].

Theoretically, all plastics require sorting, but the reality is that recycling is often restricted to easily identifiable polymers and systems, most notably high-density polyethylene milk bottles and PET soda bottles. Other polymers can be comingled into thermoplastic resins used for items such as park benches and playground equipment, which decreases the pressure to sort by specific polymer. Because polylactide is destined for commercial composting, it requires its own code and mechanisms for sorting if this advantage is to be exploited.

II LIMITATIONS OF SOLID WASTE MANAGEMENT PRACTICES

Proper waste management requires careful planning, financing, collection, and transportation. Solid waste generation increases with population expansion and economic development and poses several challenges. For example, source reduction and convenience are often opposing goals in food packaging. Convenience features such as unit packages, dispensability, and microwavability usually require additional packaging. Similarly, tamper-indication features also add to the amount of waste generated.

III CONCLUSION

The impact of packaging waste on the environment can be minimized by prudently selecting materials, following EPA guidelines, and reviewing expectations of packaging in terms of environmental impact. Still, the primary purpose of food packaging must continue to be maintaining the safety, wholesomeness, and quality of food. Knowledgeable efforts by industry, government, and consumers will promote continued improvement, and an understanding of the functional characteristics of packaging will prevent much of the well‑intentioned but ill‑advised solutions that do not adequately account for both pre- and post-consumer packaging factors. New materials, combinations, and technologies will allow the move from cradle-to-grave to cradle-to-cradle by eliminating negative environmental impact altogether [9].

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