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Effects of Single Use Plastic Packaging on the Environment

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Abstract : Packaging is one of the most important applications of plastics. In fact, about 40% of plastic materials worldwide are used in packaging applications. Plastics have contributed to creating a sustainable, hygienic, energy efficient, cost effective and friendly packaging system. Versatility of plastics has allowed creating an efficient pilfer proof, hygienic and cost-effective packaging of food products like milk, spices, edible oil, bread, confectioneries, rice, wheat flour, snack foods and various types of medicines. Plastics are used for packaging of toiletries, cosmetics, and host of other consumer products of daily and special purpose use required all – rich or poor in urban cities or in the villages.

Despite all these benefits, plastics packaging in general, and plastic bags / carry bags – which are a part of the packaging system, are under the scanner. Plastics are blamed for series of health, safety, and environmental problems. Nonbiodegradability of plastics is attributed towards causing waste management problems and choking of the drains in urban cities.

***IndexTerms* – Plastic pollution, food packaging, single use plastics, environmental hazard**

INTRODUCTION

Over the millennia, ceramic, glass, wood, wicker, and textiles have been the main materials used for containing and trading organic products and materials until the recent invention of plastics which marked the dawning of a new era (Fig. 1) (Bevan, 2014). Different properties explain the rise of plastics after the Second World War such as their extremely large physio-chemical properties that enable it to be applied to a wide range of applications at a cost that is often lower than traditional alternatives (e.g., metal, glass, ceramic). Plastics are also very simple to process, making easy to manufacture them in a wide range of objects. Thus, from the 1950s onwards, food packaging and containers, which had previously been made with traditional materials, were increasingly made from plastic materials, thus allowing better preservation of foodstuffs (Risch, 2009). At the same time, the world population increased sharply from 2.5 billion to 7.6 billion between 1950 and 2017 (United Nations, 2017). These populations also moved, migrating from the countryside to the cities where they tended to concentrate (Cheng and Urpelainen, 2015). Thus, between 1950 and 2019, the world population living in urban areas increased from 30% (751 million inhabitants) to 55% (4.2 billion inhabitants) (United Nations, 2018). These populations have increasingly easy access to consumer society, implying an increasing accessibility to consumer goods and services (Paek and Pan, 2004). These three factors (i.e. replacement of traditional manufacturing materials by plastic, increase and concentration of populations, and access to a consumer society) are widely responsible for the increasing use of plastic materials in packaging.

TYPES OF PLASTICS AND THEIR MAJOR APPLICATIONS

The various types of plastics and their major applications are as follows:
Thermoplastics: These types of plastics become soft when heated, they can be molded or shaped with pressure when in plastic state and, when cooled, they solidify and retain the shape or mold. Some common thermoplastics with their uses and properties are as follows: -

1. Polyethylene terephthalate (PET): Some common properties are:
   i. Tough and clear, good strength and stiffness, chemical and heat resistant, good barrier properties for oxygen and carbon dioxide.
   ii. It is used in-packaging, soft drink and mineral water bottles, fibers for clothing, films, food containers, transport, building and appliance industry (as it is fire resistant), etc.
2. High density polyethylene (HDPE): Some common properties:
   i. Good process ability, excellent balance of rigidity and impact strength, excellent chemical resistance, crystalline, melting point (130-1350C), and excellent water vapor barrier properties.
   ii. Used for making blow molded products (various types of containers, water bottles), pipes, injection molded products (storage bins, caps, buckets, mugs), films (carrier bags), etc.

3. Polyvinyl chloride (PVC): Its properties are:
   i. Versatility, energy saving, adaptability to changing time and environment, durability, fire resistance.
   ii. It is used in industries such as building and construction, packaging, medical, agriculture, transport. Also used for making wires and cables, furniture, footwear, domestic appliances, films and sheets, bottles, etc.
4. Low density polyethylene (LDPE): Characteristics of LDPE are:
   i. Easy process ability, low density, semi crystalline nature, low melting range, low softening point, good chemical resistance, excellent dielectric properties, low moisture barrier, poor abrasion and stretch resistance.
   ii. It is used for making carrier bags, heavy duty bags, nursery bags, small squeeze bottles. Also used in milk packaging, wire and cable insulation, etc.
5. Polypropylene (PP): Properties are:
   i. Low density, excellent chemical resistance, environmental stress resistance, high melting point, good process ability, dielectric properties, low cost, creep resistance. ii. Used for making bottles, medical containers, pipes, sheets, straws, films, furniture, house wares, luggage, toys, hair dryer, fan, etc.
   6. Polystyrene (PS): Some of the properties of polystyrene are:
   i. Glassy surface, clear to opaque, rigid, hard, high clarity, affected by fats and solvents. ii. Used for making electrical and communication equipments e.g. plugs, sockets, switch plates, coil forms, circuit boards, spacers and housings. Also used for making containers, toys, wall tiles, baskets, cutlery, dishes, cups, tumblers, dairy containers, etc.
   7. Other plastics: There are many other types of plastics except these six types, often used in the engineering sector. Examples include polycarbonate (PC), nylon, and acrylonitrile butadiene styrene (ABS).

FOOD PACKAGING

In the packaging industry, food packaging accounts for 50% of the plastics derived from fossil fuels [1]. When food is thrown away, so does the packaging material where it was contained. These fossil fuel plastics are persistent in the environment and take many years to degrade. As they do, they break into microplastics, which can easily enter the food chain when consumed by, for example, fish, leading to bio accumulation. Growing environmental concerns have placed packaging under scrutiny as it is a constant source of high amounts of plastic waste, and this has brought about the need to do extensive research into renewable alternatives.
Packaging materials in use today are chiefly fossil fuel-based plastics and their annual production continues to rise [2]. Therefore, it is imperative to bear in mind that the best solution to lower plastic waste in the environment is better waste management, particularly in developing countries [3]. The adoption of green packaging is vital, and three types of green packaging have been identified namely [4];

1. Reusable packaging, e.g., glass which can be reused after cleaning.
2. Recyclable packaging, e.g., paper which can be reprocessed and reused.
3. Biodegradable packaging, e.g., cotton sacks which can break down into the environment without causing damage.

POTENTIAL CHEMICAL EXPOSURES FROM PACKAGING

It is well known that chemical components from packaging can migrate into foods, but questions of how much migration occurs and what the potential health effects may be are gaining more attention from researchers and regulators.[5] However, few studies to date have looked at adverse human health effects of these exposures.
Different types of packaging materials pose different potential chemical exposures.
studies have found chemical contamination of food coming not from glass itself but from materials used to seal the metal lids on glass jars. In work by a Danish group, some foods in glass jars sealed with polyvinyl chloride (PVC) gaskets were found to contain di(2-ethylhexyl)phthalate (DEHP) and other phthalates at levels deemed unacceptable by the European Food Safety Authority.[6],[7] These studies did not assess potential health effects from this exposure, but in other studies phthalates have been associated with endocrine disruption in humans.[8],[9],[10]
Environmental health concerns associated with the use of paper food packaging have focused on the use of recycled paper products. Printing inks from earlier incarnations of the paper can be trapped in this material, potentially exposing consumers to phthalates as well as to other suspected endocrine disruptors, including benzophenones and mineral oils.[5] A study conducted by a German group showed that infant foods packed in recycled paperboard boxes with coated paper liners were contaminated with diisobutyl phthalate and di-n-butyl phthalate, with a few samples containing the former at levels exceeding European Commission limits for food contaminants.[11] The authors noted that inner liners made of aluminum-coated foil were much more effective than coated paper at blocking the migration of phthalates from recycled paperboard packaging.
There also have been problems with the liners themselves in some paper boxes. In 2010 Kellogg Company recalled 28 million boxes of cereal because of elevated levels of methylnaphthalene [12] that leached from the coated paper lining the boxes.[13] Although the potential consequences of ingestion of this compound are not well understood, at least five consumers reportedly became ill after eating the contaminated cereal.[14]

SOLUTIONS TO ADDRESS ENVIRONMENTAL IMPACT

Efforts to address the environmental impacts of packaging include those that aim for source reduction, reuse, and recycling.
Reduce: Source reduction can be achieved by “light weighting,” or using less material to make the same packaging. Glass containers have decreased in weight by nearly 50% in 10 years, and between the 1970s and 2000s, two-liter PET soft-drink bottles got 25% lighter, aluminum cans got 26% lighter, and steel cans and plastic grocery sacks each lightened up by 40%.[15],[16] Another form of light weighting is the use of pouches made of a thin film of plastic combined with other materials. The Swedish packaging developer Ecolean produces a one-liter pouch that weighs only 16 grams, nearly half as much as a one-liter polyethylene terephthalate (PET) bottle.[17]

Reuse: Reusable and refillable containers are another way in which companies can implement source reduction. Although refillable milk bottles are no longer common in the United States, they are still used in some areas of Britain where milk production is local. In Germany, about half the soft drinks and mineral water and most of the beer is sold in refillable bottles.[18]

Recycle: Recovery for recycling is encouraged by beverage container laws, also known as "bottle bills," in which a cash deposit of 5–10¢ is added to the product and reimbursed when the empty container is redeemed. Currently only 10 U.S. states have such laws in place—California, Connecticut, Hawaii, Iowa, Maine, Massachusetts, Michigan, New York, Oregon, and Vermont (unclaimed deposits, which can amount to millions of dollars per year, revert to the state and/or bottlers and distributors).[19] According to the nonprofit Container Recycling Institute, states that do not have bottle bills have a beverage-container recycling rate of about 24%, whereas states with bottle bills recycle about 60% of their containers.[20]

Glass can be recycled endlessly with little loss of quality or purity of the material. The demand for glass for recycling exceeds supply, with only 33% of discarded glass bottles and jars actually recovered for recycling in 2010. Paper food packaging is one of the least recycled materials, with 25% of discarded cartons, boxes, and bags recovered for recycling the same year. Steel cans were the most highly recycled metal food packaging material at 67% recovery, followed by aluminum cans at 50% recovery. Just under 30% of PET and high-density polyethylene (HDPE) containers were recovered.[21]

Although most food-packaging plastics can, in theory, be melted to make new products, some are easier and cheaper to collect and process than others, and the demand for recycled plastics differs by material, according to Steve Russell, vice president of the Plastics Division of the American Chemistry Council. Metallized plastics and laminates such as those used in juice pouches are difficult to recycle because of the mixtures of materials used. However, Teracycle, a Trenton, New Jersey–based recycling company, collects these and other types of hard-to-recycle waste and "upcycles" them—that is, uses them to create new and innovative household and personal items.[22]

CONCLUSION

Plastics are still a consumer preference material for packaging solutions. They are the most produced material globally for different application markets including electronics, automotive, agriculture, toys and textiles. They have found high uptake in packaging industry particularly in the food industry where the packaging is mostly single use. At the end of their very short useful lifetime, these plastics easily find their way into the environment. In the environment, plastics can negatively affect animal and human health as they pollute land and water bodies and even find their way into the food chain. This has resulted in a growing need to provide packaging material that is economic, convenient, and environmentally sound. While the search for environmentally friendly packaging is ongoing, there is need to adopt the reduce, reuse, and recycle model. Governments must play the key role to regulate, businesses should innovate, institutions should research, and individuals should act. Together, a working society can achieve a plastics circular economy with effective waste management systems to curb the pollution problem from plastic use. This will be particularly important in India as studies project that the continent would be the biggest consumer of food packaging plastic materials.

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