

## Plastic in Food Packaging: Safety Concerns for Our Health and Environment

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### Introduction

Since ancient period food has been preserved by man in dried gourds, coconut shells, hollow sticks, leaf pots and pottery. Chinese use to wrap foods with tree bark treated with suitable materials in the first century BC. In the Franco-Austrian War of 1809 Napoleon Bonaparte used canned food to nourish his troops. In our day-to-day life, food packaging has many close associations with cereal in a paperboard package, a can of energy drinks, frozen fish & meat goods, a plastic water bottle, a plastic bag lined with foil along with potato chips and a fruit with shrink-wrapping. Food packaging material has so many benefits of containment to increase shelf life and moreover packaged food is very convenient and safe. Food convenience is a good idea to grab a food and go with the pack. Chemical components from packaging has the chances to migrate into foods but what matters the most is the intensity of migration that happens and what the possible health hazards on the human body would be. To date, the experts have been through a few trials and looked into the harmful impact of allergies to food packaging for public safety. Not only is plastic to be blamed, but there are also products to be protected that are constructed from sequence of organic and inorganic compounds. Plastics are molded and reinforced with several chemicals and two of these plasticizers are combined with Bisphenol-A (BPA) to create transparent, rigid plastic and Phthalates are mixed to render plastic smooth and versatile.

Research findings have shown that BPA can move from packets into food or drinks and the consumption is of considerable concern due to potential health effects of BPA on the skin. Prostate gland of babies and children or fetuses is also effected and have elevated blood pressure [1]. On wrapping food in plastic or heating food in the microwave, BPA and phthalates leak into the food. Migration is considered to be higher with foods such as meats and cheeses when compared to certain foods [2].

The environmental effects of disposable food packaging have emphasized around the usage of paper recycled items. Printing paper inks will theoretically lead customers to phthalates, benzophenones and mineral oils that may induce dysfunction of the endocrine [3]. The environmental effect of supermarkets was only investigated in a few reports. Marrucci et al., proposed that classifying the forms and amounts of solid waste and the resources available for separate disposal of waste would allow businesses to achieve environmental and economic benefits [4].

Research studies depict that internal coating made of aluminum-lined foil is far more useful in preventing phthalate migration than recycled coated material. Although several paper boxes had issues with the liners themselves. In 2010 Kellogg Corporation was confirmed to have recalled 28 million boxes of cereal-based food due to elevated amounts of methylnaphthalene found to have leached from the boxes with coated paper. The possible problems of consumption of this chemical compound are not so obvious, however, after consuming the contaminated food, at least five customers were declared sick.

The usage of epoxy based resins which are Bisphenol A (BPA) in metal can liners (BPA is often found in rigid, transparent polycarbonate plastic) is probably the biggest present controversy on food packaging. The Natural Resources Defense Council (NRDC) recommended the FDA to prohibit the use of BPA in food packaging, although the recommendation was rejected by the FDA.

Food packaging involves both art and technology that have advanced a long way and now goods are mostly packaged in several layers of packaging to keep them healthy and wholesome for customers from the point of manufacture. Food packaging increases consumer health by preventing infection of the bacteria. Food packaging plays a key function in food safety across the whole delivery chain. Food packaging has been an essential component of food manufacturing.

Food packaging for fresh products not only avoids degradation, it also improves the shelf-life of items, and in the present scenario helps with massive delivery and lower food waste.

Different food packaging materials have different advantages as well as disadvantages. Glass is chemically inert and preserves the taste of food well. Paper and paperboard are good to manufacture economically, and can be conveniently printed out. They are also light weight and helps with products being transported easily. Iron and aluminum have the qualities of being malleable, impermeable and simple to recycle. Aluminum may also be conveniently attached to paper or plastic sheets, enabling the range of food packaging materials. The food packaging industry has revolutionized plastics as they can be shaped into unlimited forms and are lightweight, cheap, simple to seal and durable.

Plastics include chemical additives that improve the consistency of the material for its intended use, and their toxicity is not well known and is not checked adequately. The chemical contaminants found in them are hazardous such as the plastics pesticide Bisphenol-A (BPA) and the plastic softeners phthalates. Plastics chemicals randomly migrate and are leached into the food and water contained in them. This amount even in small quantities is not proven safe for health point of view.

## Plastic Not So Fantastic

Plastics are ubiquitous today and they should be selected carefully to minimize exposures. Practically, they cannot be eliminated from food usage. More emphasis should be given on plastics which come in contact with the mouth and in turn to the internal body parts. Plastic contaminants may come into contact with the mouth in a variety of places, such as through hands, food and beverages, and are extremely significant in small children who sometimes place hands and items in their mouth.

## Aims and Objectives

- Study of recent trends in Food Packaging
- Effects of plastic food packaging on Public safety
- Effects of disposable product packaging on environment

## Review

A Texas test analysis focused on the examination of processed foods found that the chemical contained 60% of samples of natural, plastic-wrapped and frozen products. BPA consumption was observed for adults and children who are consuming daily portions. The values appeared between the reference dosage set by the Food Safety Science Committee of the European Commission which is 10 micrograms per kilograms per day and the United States as 50 micrograms per kilogram EPA per day. Even though approximate

doses from consuming any one food is low, there are several sources of BPA ingestion, and studies indicate that BPA and other chemicals disrupting endocrine glands and thus causing unintended effects even at very small doses, but the rates are still not established [5].

Analysis experiments performed by a Danish group indicated that certain products were found by the European Food Protection Authority to contain di (2-ethyl hexyl) phthalate (DEHP) and other phthalates in jars made of glass filled with PVC (polyvinyl chloride) gaskets at non acceptable levels. Nevertheless, possible health risks from this intake have not been evaluated, but other similar studies have found an association of phthalates with endocrine dysfunction in humans. It was also recommended that BPA will not stay in the body for longer than a few days because when consumed, it is broken down into glucuronide and is readily excreted waste substance. Glucuronide was contained in most urine samples, which suggests persistent BPA exposure [6]. According to the American Chemistry Council's BPA regional community the reaction was a standard low-level reaction. Chemist Steven Hentges, Executive Director, claims polycarbonate / BPA is regularly used in cans for rust protection and degradation of food. It also makes clear and shatterproof plastic cups and infant and other bottles.

According to a study performed by Scott Belcher, an endocrine biologist at the University of Cincinnati, BPA leaches 55 times faster than it does under standard circumstances when polycarbonate plastics and epoxy resins produced from the material are subjected to hot liquids. It was also emphasized that when boiling water is applied to polycarbonate bottles, the seepage rate has risen to 32 nanograms per hour.

Latest studies from the journal Reproductive Toxicology human being will be at least 10 times exposed to BPA amounts that the EPA has considered safe due to the amount of contaminants found in tissue and blood samples [7]. According to Laura Vandenberg, a developmental biologist at Boston's Tufts University, if any, data suggest that humans are metabolizing BPA faster than rodents, then human routine intake will have to be much higher to achieve the levels found in human serum.

Based on a survey, 93 % of 2,157 individuals aged 6 to 85 were tested and found to have detectable levels of the by-product of BPA in their urine [8].

US endocrinologist Retha Newbold said children have higher rates than teenagers and teens than adults. Polycarbonate plastics and epoxy resins made from the chemical have known to affect reproduction in female mice due to BPA when exposed to hot liquids. After very brief periods of exposure to animals BPA can trigger lasting results and it does not have to remain in the body to have an effect.

The Bisphenol A (BPA) compound was synthesized in 1891 and has been a primary building block in polycarbonate-to-polyester

plastics. Throughout the United States alone, 2.3 billion pounds (1.04 million metric tons) of materials are manufactured annually.

The Food and Drug Administration has licensed the usage and the EPA does not find it to be a reason for distress and thus opinions of scientists remain split about the possible safety risks to humans. A jury at the U.S. National Institutes of Health (NIH) accepted, yet another committee of government experts noticed that the volume of BPA contained in human being reached amounts that induced harmful animal symptoms. Researchers also found that the capacity of adults to withstand it does not prevent the harmful consequences of children and babies. Unborn baby and children are a source of concern since BPA has been related to increased breast and prostate cancer and has also altered menstrual periods and induced diabetes in growing lab mice.

Steve Russell, vice president of the Plastics Division of the American Chemistry Council, confirmed that phthalates are neither used in plastic water bottles nor are they used in plastic food wrap, food container or some other form of plastic food packaging sold in the United States. It was claimed that very little PVC is used in food contact in the United States, except for meat and cling wrap. In such applications, phthalates were replaced with alternative plasticizers like di-(2-ethylhexyl) adipate. Adipates have been shown to possibly leach into food, and their effects are being studied in laboratory animals, but there are no known effects on humans. Several alarming contaminants, such as phthalates, have been phased out of use in food packaging.

Benignus et al. suggested that long-term styrene exposure can have a range of effects on the nervous system [9]. He measured exposure concentration of styrene from biomarkers, and important associations between combined exposure to styrene and improved choice reaction time was demonstrated.

The innovative food packaging technologies have raised the number of hazards due to the shift from packing material to packaged goods, The studies by Arvanitoyannis and Bosnea 2004 have shown that migration often exists from conventional materials commonly considered healthy (GRAS) such as paper, cardboard, wood, ceramic, and metal. EU laws and guidelines strive to get stricter against the same. More research emphasis has been given on the migration of chemicals in food through food packaging. Product health should be in line with the HACCP and therefore harmful monomers, oligomers and chemicals are a concern.

According to Markey et al., Bisphenol A (BPA) which is an endocrine disruptor is used in a wide variety of consumer goods manufacturing [10]. Developing rodent reproductive organs are altered after BPA application [11]. Exploration of BPA exposure on a pregnant woman and her fetuses is also required.

According to Ikezuki et al., there is large human exposure to Bisphenol A (BPA) which is commonly used to manufacture plastic

goods is an estrogenic endocrine disrupting chemical [1]. BPA was shown to affect embryos or fetuses in pre-implantation and even altered the postnatal growth in embryos or fetuses at normal doses. A novel enzyme-linked immunosorbent assay (ELISA) was also used to test toxicity of BPA in different kinds of human biological fluids. The findings indicate accumulation of BPA in early fetuses and substantial prenatal exposure [12].

Vom Saal and Hughes in 2005 reported that the leaching of BPA in such BPA-based polymers have contributed to considerable human exposure due to the hydrolysis of ester bonds [13]. Bisphenol A (BPA) is the monomer used in the production of polycarbonate plastic, cans rubber covering and other items, with an estimated global potential of more than 6.4 billion pounds.

A study conducted by University of Missouri Endocrine Disruptor Group in October 2006, F vom Saal found the support for low-dose effects of BPA is insufficient based on a sample of only 19 trials [14]. The reports were published based on the effects of low-dose BPA on the in vivo studies, and many of those reports showed significant effects. Significant effects occurred in 31 publications with vertebrate and invertebrate animals below the "safe" or reference dose of 50 µg/ kg /day BPA [13]. In vitro studies indicate an estrogenic mode of action of BPA which causes disruption of cell functions. Food suppliers tend to ignore such results as no industry-funded trials have recorded significant effects of low-dose BPA, while more than 90 per cent of government-funded research has documented significant effects. Although 92% of the 163 government-funded studies reported significant development, reproductive or immune effects from low-level BPA exposure, none of the 13 industry-funded studies found significant effects. Animal research report low-dose results at dosage levels hundreds of times lesser than the current standard the Environmental Protection Agency deems "healthy".

BPA should be evaluated for damage based on

- (a) Comprehensive recent research will identify adverse animal effects at doses below the existing reference level.
- (b) The high rate of BPA leaching from food and drink containers that leads to human exposure.
- (c) Studies that levels of BPA in human blood and tissues, including human fetal blood, are greater than those causing adverse effects in mice.
- (d) New epidemiological findings suggesting that BPA is likely to cause illness in women.

Sugiura-Ogasawara et al., proposed that more work is required for the effect of high exposure to Bisphenol A on recurrent complications of miscarriage and immunoendocrine [15].

A new Harvard University study showed that college students consuming their cold beverages from polycarbonate bottles have 93% more BPA in their bodies than those consuming liquids from other containers.

The number of people suffering from problems such as kidney, throat, cancer and infertility in North Coastal Andhra Pradesh and the spike in these cases is primarily attributable to people’s dietary patterns as they ingest hot foods kept in plastic bags. Hundreds of patients are affected by polyvinyl chloride, polyethylene and polystyrene due to consuming hot foods in plastic bags and frequently visit the state-run King George Government Hospital (KGGH). These patients are from cities, villages, and even tribal areas of AP and neighboring Chhattisgarh and Orissa states in the North Coastal districts.

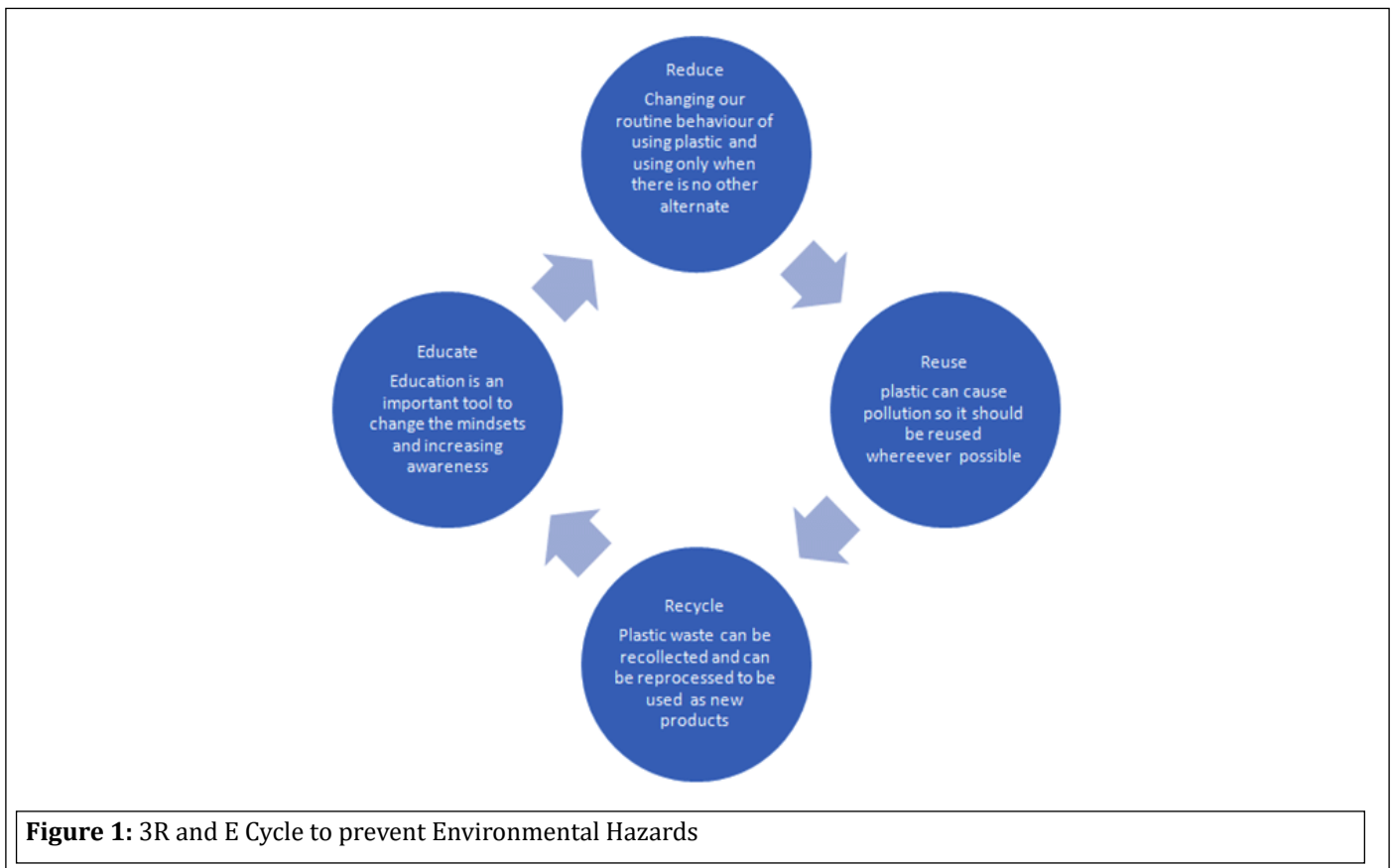
Hospital superintendent Dr M Madhusudan said the number of patients suffering from cancer of the kidney and throat and infertility has risen at the KGGH over the past two years. The patients consumed tea, coffee, milk, beans, and curries in plastic containers.

Data shows that all plastics that leach chemical compounds if plastics are rubbed or heated and some of the chemicals in such materials, such as Bisphenol A (BPA), may be highly cancerous at some exposure rates [16]. When hot food is wrapped in plastic, high temperature maximizes the chemical interaction between plastic and milk, which affects the quality of the product. Since plastic bags are not biodegradable, the day-to-day use of plastic bags in our lives has also contributed to environmental hazards.

Toxins may move into the substances they carry the plastic from. Migration of low molecular weight substances including stabilisers, plasticizers, antioxidants and monomers from plastic packaging materials are the most popular food interactions. Any plastic bags may allow chemicals to leach into the food. Such contaminants include styrene and bisphenol-A that may induce cancer, heart failure, and difficulties with reproduction [17]. Further evidences can be have from styrene fact sheet produced by U.S. EPA, Styrene Fact Sheet [18].

Water in plastic containers has been often unsafe for human use because, when loaded into vehicles, the tanks are typically subjected to intense sunlight.

A report from the Official Food Safety Authority of Canton Zurich, Switzerland, stated that the movement of toxins from food packaging could well exceed that of other chemicals, such as pesticides and pollutants, A study by Natureworks website recorded that the most significant source is migration from packaging content & it beats most others by a factor of 100–1000 [19]. Plastics labeled with 1, 2, 4 or 5 have no BPA and may be safer options. Pollution caused by plastic can be prevented not only by cleaning water bodies but also by adapting a change of our mindset and habits of using this harmful packaging material. Solution to the prevailing problem can be followed as given below [Figure 1].



**Figure 1:** 3R and E Cycle to prevent Environmental Hazards

## Summary and Conclusion

Food packaging is a lot more than just holding a food. It keeps food healthy, fresh and prolongs the food shelf life. It also provides information related to food and display barcodes which encourage the purchase. This also offers nutritious content, thus preserving goods during shipping, distribution and storage. But on the other side, packaging still takes up garbage cans and landfills, and would last for longer than the items it was designed to produce. It consumes natural resources and it may also move contaminants, with uncertain health consequences, into our food. Thus, our relations with packaging are complex.

According to Institute of Medicine National Academies Press, the possibility of persistent contaminant ingestion from food packaging is challenging to predict, since very little is understood [20]. At this point, it is much more challenging to quantify any public-health consequences that might occur from the intake or to balance the possible adverse impacts against the established advantages of decreased spoilage and microbial pollution

Secure Plastics: 1, 2, 4 or 5-marked plastics do not produce BPA and might be safer alternatives.

Unsecure Plastics: Keep away from goods containing a “3” or “PVC” label (PVC stands for polyvinyl chloride, also known as vinyl). PVC is also combined with phthalates, a poisonous chemical that enables more consistency in plastics.

Evade containers of polycarbonate (sometimes numbered with 7 or “PC”). These materials, e.g. acrylic food storage containers and water bottles, are solid and translucent. Trace quantities of BPA will move primarily in the case of hot foods or liquids from such containers. The material, smooth or opaque, does not produce BPA.

## Environmental Impacts

While food packaging is essential for sanitation and convenience, the extent and effect of chemical pollution of food with packaging materials should be better understood. Pesticides are tested and are well regulated in their application, and only a limited fraction of the compounds that move from food packaging have been assessed, and the rest has not yet been reported. Even if fifty to one hundred thousand sub-stances move from plastics into products at rates that often reach the toxicological threshold, then even one out of a hundred substances affects our safety, that is likely to trigger significant damage. “Plastic causes major environmental issues. The plastic bags used for food processing are particularly harmful since they contain polystyrene, polyethylene, polyvinyl chloride. Marrucci et al., highlighted a significantly different level of attention within the Sustainable Consumption and Production (SCP) tools [21]. The Environmental Management System (EMS) and the Ecodesign Regulation are the two key instruments under review and has suggested three key paths for the potential study agenda.

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