

The Prevalence and Environmental Impact of Single Use Plastic Products

-Tarique Zaman

Plastics have been around for a long time now. It has been said that even before Alexander Parke's major pioneering contribution to the development of plastics from cellulose nitrate in the 1850's, plastic like materials have been in use by mankind for centuries. However in the current era life without plastic cannot be imagined. Almost every article of day to day use that we may lay hands on is either a plastic or has plastic components in it.

Because of the immensely versatile nature of plastics to be made into products of varying strength and flexibility that we find plastic products ranging from car bodies, home and office furniture, computers, water bottles and as package materials for almost everything that needs transportation and storage. Besides since plastics are mostly made from the byproducts of the petroleum manufacturing processes, they are very inexpensive.

The increasing prevalence of plastic use has also resulted in it being incrementally adding to the Municipal Solid Waste (MSW). According to the EPA website (<http://www.epa.gov/osw/conserves/materials/plastics.htm>) the contribution of plastics to MSW in 2008 in the US was 30 million tons which is nearly 12% of the total. When we compare this to the plastic content of MSW in 1960 we find that it contributed only to 1% then. Of the 30 million tons of plastic waste in the US in 2008, 13 million tons was single use plastics.

Single use plastics are essentially the plastic products used for packing purposes of almost all manufactured products from the most high tech equipments like computers to the most basic ones like drinking water.

In general the major groups of plastics are listed as under

Types of Plastics	Applications
HDPE High-density polyethylene	milk jugs
LDPE Low-density polyethylene	Plastic bags
LLDPE Linear low-density polyethylene	Plastic bags, sheets, stretch sheets
PET Polyethylene terephthalate	soda bottles
PP Polypropylene	long underwear
PS Polystyrene	Disposable razors, CD case, packing foam
PVC Polyvinyl chloride	pipes

Source <<http://www.epa.gov/osw/conserves/materials/plastics.htm>>

Based on the usage, we may further classify plastics as durable (e.g. plastic furniture, appliances), nondurable (e.g. plastic utensils, diapers, trash bags and medical equipments) or packaging/container plastics (e.g. plastic bottles, shopping bags). Single use plastics belong to the non-durable and packaging group. In this discussion on single use plastics I will be focusing on the packaging and container plastics.

Plastics are manufactured from petroleum products and currently account for 4% of the petroleum consumption with additional 4% in terms of energy used in the manufacturing process. One third of this goes on to be used in packaging material which get discarded after their first use- the single use plastics. Hence as a concluding part of a series of research papers, Thompson et al, go on to question the sustainability of the plastic in the future if it's consumed at the present rate[1].

Toxicity of Single Use Plastics on Human

The issues surround the toxicity to human from the single use plastics are primarily due to their use in packing food stuff. Here drinking water bottles are often the most talked about sources of toxicity to humans from plastics. Phthalates and Bisphenol A (BPA) are the two most notorious toxin which leach from plastics into the contained food or water. Moreover when these single use item are discarded improperly, they often end up in water bodies where they continue to leach these harmful chemical for an very long time, on account of being non biodegradable.

Phthalates, have been found to deposit in the fatty tissues of the body, where they act as antiandrogens. Recent studies suggest that these phthalates have a role to play in human disease like male reproductive dysfunction, breast growth and testicular cancers [2].

BPA which is often found in the food grade plastic known as polycarbonates, also used in hospital disposables, has been found to have an estrogenic side effect profile. It is found to have detrimental effects on human placental tissues. Therefore BPA has been linked with premature birth, intrauterine growth retardation, preeclampsia and still birth [3]. These conclusions are mainly derived from animal studies which have also shown that BPA has carcinogenic effect on prostate and breast besides altering the normal development of the prostate and urinary tracts in the rodents. There has been experimental evidence for delayed neurological development. Recent mice studies have shown that estrogenic effect of BPA may also have a role in insulin resistance and diabetes [4].

However due to the different manufacturing process different plastics have different levels of these toxins. Table 1 shows the different icons used on food grade plastics to guide consumers about the safety of the plastic constituents. Considering the prevalence of microwave ovens, it must be kept in mind that heating of the more dangerous plastics increases the leaching of the toxic chemicals and hence is an important issue with the rise of precooked and/or frozen meals in plastic containers.








Safer Choices: Select safe plastics that use polyethylene (#1, #2, and #4) and polypropylene (#5), which require the use of less toxic additives. They also are non-chlorinated.			
			
Polyethylene (PETE)	Polyethylene (HDPE)	Polyethylene (LDPE)	Polypropylene (PP)
Unsafe Choices: Avoid choosing products that use polyvinyl chloride (#3), polystyrene (#6), and polycarbonate (#7) which often are found in baby bottles or sippy cups.			
			
polyvinyl chloride (V)	Polystyrene (PS)	Others, e.g. polycarbonate etc	
Adapted from:		http://healthychild.org/5steps/5_steps_5/?gclid=CKLK-6Sn6aACFeg85QodEFQDBq	

Table 1-Resin Identification Codes and Safety Levels- RIC as found embossed on the under surfaces of food grade plastics-These are used essentially to segregate plastics before recycling.

Environmental Health Risk

Plastics degrade very slowly in nature. Because of their intermolecular bonds some plastics may persist in the environment for thousands of years. Because of the low density they also tend to float in water. Hence plastic discarded in watershed areas, which invariably all areas of human settlement are, get collected in the rain water sewers. Sometimes due to prolonged intervals of retrieval, they choke these rainwater outlets. The uses of thinner plastic bags have increased the risk of sewer blockages. In China and Bangladesh, it has been the reason for exacerbated flooding during the rainy season. However more often these hardy plastic discards find their way into the rivers and from there to the seas.

The plastics that enter our water-bodies like lakes and river, continue to get leached on their journey downstream to the oceans. Sometimes they may be inadvertently eaten up by fishes and sea animals. These organisms often die from the harmful physical and chemical impact of these chemicals. For those that survive, this results in the

accumulation of toxins in their bodies. If they are a part of our food chain, then biomagnification causes the accumulation and display of harmful effect on the human body. Hence what we inadvertently dump into the environment, comes back to harm us in a much more concentrated form.

As per available data from the California based, Algalita Marine Research Foundation (AMRF), plastics in the world's oceans weigh over 100 million tons. Eighty percent of these are from watershed regions of the world. These are contributed by improperly disposed plastic waste on the streets, garbage left by the beach visitors and also unused plastic pellets lost during plastic manufacture.

Of note are the Eastern and Western Garbage Patches in the Pacific Ocean. These huge partially submerged islands of garbage composed mainly of plastic debris, has been prime focus of the AMRF. They have noted plastics in this garbage patch circulate there for the at least 12 years. Photodegradation does help break the floating debris over time, however plastics that are not light enough sink to the floor. They do not degrade that quickly and continue to trap and kill fishes [5].

For all the plastics that we care to "properly" dispose, get collected as the Municipal Solid Waste (MSW). After sorting into different categories, the majority of the plastics end up in the landfills. By early 1990's two-thirds of the landfills in the US had already been exhausted. The current state could not be confirmed by the author but should be substantially more. These landfills have been found to be environmentally hazardous to the population living nearby. Mothers living close to landfill areas in Love Canal, Niagara Falls have been found to bear growth retarded babies [6]. Besides there are several reports of increased incidences of cancers in the people living near landfill sites.

Impact on Vulnerable Population

We cannot help miss the frequent warnings on plastic bags to not be treated as toys. So the immediate risk of the plastics to be able to suffocate individuals deserves very careful handling in the presence of small children in the household. Care is often advised to make sure that plastic covering of all mattresses in the house are meticulously removed to reduce their risks.

The other aspect of the harm of plastics are the effects of chemical additives in plastics often pronounced in newborns via mother exposed to these toxins during their pregnancy and the second vulnerable group is the young children who directly encounter these chemicals in their surroundings.

Since many of the chemical like BPA and phthalates can cross the placenta, they result in growth retardation and neurological harm. As stated earlier, there are also evidences to suggest hormonal derangements and cancers in children.

Small children on account of their weight suffer greater impact of toxins than adults. The newly developing brain and nervous system in the young population gets negatively impacted by the toxins which often interfere at the genetic level cause mutations and

increase risks for malignancies later on. Further during the course of their growth into adulthood, tend to accumulate these chemical in the fatty tissues and manifest adverse health conditions later on in life.

Remedies to the single use plastics problem.

A series of interlinked steps must be adopted to resolve the problems caused due to single use plastics.

1. Reducing the dependence on single use plastics- First and foremost, individuals need to decrease their dependence on single use plastics. There already are numerous alternatives to plastic shopping bags and water bottles. However, it's not yet a big success because of the lack of information among the public and selfish commercial interests of the of plastic industry that insures that our dependence on single use plastics continues. The governments and concerned organization must work toward promoting reusable alternatives.

Hence massive public awareness campaigns on the ills of single use plastics is vital. However care must me taken to ensure that the public is well aware of all the possible safe alternatives.

2. Increase taxes on single use plastic products- The fact is that businesses like plastics because they are the cheapest of all packaging materials. This needs to change. Governments need to tax plastic even if it is only to reduce consumption. In 2002, Ireland became the first country to introduce a tax on plastics. This is known as PlasTax and was found to reduce plastic bag consumption by 90%. The mere imposition of \$ 0.15 on each plastic bag was enough to bring about this massive change. As collateral benefit, the government generated \$ 9.6 million from taxes in the first year. People now use reusable bags for almost all grocery needs, except in certain commodities like meat, fish, poultry or unpackaged fresh produce where these taxes are exempt. Several other countries like UK and Australia and cities like New York are planning to implement similar taxes [7].
3. Adoption of biodegradable plastic bottles- Since it is expected that single use plastic bottles will be in use for a while, we urgently need to find the best and safest alternatives to the materials used to make these plastics. Biodegradable plastic are designed to decompose both in the presence or absence of air. The molecular bonds are such that they are susceptible to bacterial degradation to safer by products.

The American Society for Testing and Materials is the national organization setting the standards for an acceptable biodegradable standard in

the US. Only after a material passes the two specific test specifications, can they carry the “compostable” label.

4. Of late, the use of bioplastics is increasing. Bioplastics, unlike conventional plastics is manufactured from renewable resources like vegetable oil, corn or pea starch. These plastics donot require the toxic chemicals as additives and hence are environment friendly. However, although it decreases our dependence on fossil fuels for plastic manufacture, the bioplastics are essentially not designed to be biodegradable.

Another flip side to the issue is that since the technologies to manufacture bioplastics is new, it is not yet as cost effective as petroplastics.

5. Improving recycling technologies: Table 1, shows the Resin Identification Codes for plastics. Although it can be used to differentiate safe plastic from non safe ones, the primary purpose for RIC is to help in the recycling of the plastics. Recycling of plastics is very essential to slow down the ever increasing plastic waste burden on the environment. The more is the use of virgin plastic in the manufactured goods, the more is the amount of plastic in circulation. These plastics will eventually be discarded and head to the garbage bins and ultimately to the landfills where they stay put for a long long time.

However, plastic recycling is easier said than done. The challenges in plastic recycling is the difficulty in segregation of plastics in one of the 7 different groups and also cleaning of the plastics from the various contaminants like food debris, wet paper etc. The cost and efforts to accomplish this is an major factor accountable for the dismal real world recycling efforts.

7. Finally, implementing bans on plastic only after sufficient alternatives have been accepted and in good supply in the community. So the key is developing the alternatives to conventional plastics and promoting them for use. Only once it is widely prevalent in the society, should we consider a ban on conventional plastics.

Since use of single use plastic have become so integrated in our way of life that the legal option to drastically cut it's use is going to be a very arduous task. The debates over cost effectiveness of plastics versus the alternatives may not be that simple to begin with. Especially since, there is something immeasurable at take i.e. a better future for our environment in the decades to come.

Research Needs

Biodegradable Plastics- These are an answer to many of the problems due to the single use conventional plastics. One of the common constituents of biodegradable plastics is polyhydroxyalkanonate (PHA). It is similar to conventional plastics in all

aspects with the additional quality of being able to naturally decompose and break into natural and safe byproducts. Hence if all plastics in the city waste was biodegradable, it could simply be allowed to decompose along with the food and other non recyclable but biodegradable articles like wet paper and cotton fibers. Hence, without much human intervention, these plastics would be able to find a safe end to their existence.

The issue to think about here is again, the cost and feasibility. Since the technologies to manufacture biodegradable plastics is relatively new and not widely prevalent, the production cost is higher. In fact, the energy spent on the production of such plastics is also found to be slightly higher than. Therefore, further research in areas of more cost effective and energy efficient manufacturing methods for biodegradable plastics is the call of the hour.

Bioplastics- As discussed earlier, bioplastics are not derived from petroleum products. However, that does not imply that bioplastics can naturally decompose like biodegradable plastics. The prime benefit is that it gives some respite to our depleting petroleum reserves. However, that's not completely true, because the manufacturing process requires energy which often comes from fossil fuel.

Hence, further research should focus on developing bioplastics that are both biodegradable and also energy efficient to produce.

Recycling techniques- This deals with the tonnes of plastic waste that is choking earth. So in addition to developing smarter plastics that takes the place of conventional plastics, we also need to deal with the immense quantities of toxic wastes already out there and hurting humans and the environment.

Smarter sorting of Municipal Solid Wastes, more energy efficient ways of getting rid of the plasticizers from these items and increasing the scale of this entire process is very vital to overcome this challenge.

Recent reports of discovery of certain fungi and bacteria that hasten degradation of conventional plastics has received a lot of media and scientific attention. The research efforts are rightly guided in determining that in this process, the byproducts of this natural way of decomposition is safe for the environment and there are no hidden adverse consequences of this approach.

It's also heartening to note that, research studies have tried to utilize waste plastics as additives to road building material because of the common petrochemical origin of tar and plastics.

These are a few of the several ingenious ways in which science is being used to undo the human and environmental consequences of indiscriminate use of plastics-a "wonder" product of science itself.

References

1. Thompson, R.C., et al., *Plastics, the environment and human health: current consensus and future trends*. Philos Trans R Soc Lond B Biol Sci, 2009. **364**(1526): p. 2153-66.
2. Jobling, S., et al., *A variety of environmentally persistent chemicals, including some phthalate plasticizers, are weakly estrogenic*. Environ Health Perspect, 1995. **103**(6): p. 582-7.
3. Benachour, N. and A. Aris, *Toxic effects of low doses of Bisphenol-A on human placental cells*. Toxicol Appl Pharmacol, 2009. **241**(3): p. 322-8.
4. Alonso-Magdalena, P., et al., *The estrogenic effect of bisphenol A disrupts pancreatic beta-cell function in vivo and induces insulin resistance*. Environ Health Perspect, 2006. **114**(1): p. 106-12.
5. Update. *Environmental Protection Agency*. Wallace, N. (1985) Debris entanglement in the marine environment: A review, pp. 259-277).
6. Paigen, B., et al., *Growth of children living near the hazardous waste site, Love Canal*. Hum Biol, 1987. **59**(3): p. 489-508.
7. Web reference <http://www.reusablebags.com/facts.php?id=20> accessed as of April 6, 2010.