

Impact of Plastic Pollution on Environment and Human Health: An Overview

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Abstract- Increasing demand of plastics and plastic products by human being are responsible for plastic pollution in the environment. The present papers deal the ill effect of plastic pollution on environment and public health. More than 20 different major types of plastic are used worldwide and over 300 million metric tons of plastics are produced in the world annually. Plastic are made from chemicals and contain large amount of toxins like BPA, phthalates and others. Long term usage and exposure of plastics and plastic products to high temperature can lead to leaching of toxic chemical constituents into food, drinks and water. Indiscriminate disposal of plastics on land and open-air burning can lead to the release of toxic chemicals into the air causing public health hazards. So, it's time to rethink about the production, use and disposal of plastics to save human life.

Indexed Terms- Environmental contamination, Plastic Pollution, Public health, Toxic chemicals.

I. INTRODUCTION

Plastics are essential materials in modern civilization, and many products manufactured from plastics which are used our everyday life. Plastic makes our life easier and better. Day by day peoples are becoming more and more dependent on the use of plastics because of the characteristics of plastic such as inert, durability, flexibility and versatility and so on. Plastics have many benefits and without plastic, modern society would indeed look very different. Plastics are being used by people without knowing the toxic effects of plastic on the health of human, other organisms and environment.

Plastic are composed of a network of molecular monomers bound together to form macromolecules of infinite use in human society. Today, there are more than 20 different major types of plastics in use

worldwide (APME, 2006). Plastic have transferred everyday life; usage is increasing and annual production is likely to exceed 300 million tonnes by 2010. Plastic brings many societal benefits and offer future technological and medical advantages. However, its usages and disposal are diverse and include accumulation of waste in landfills and in natural habitats, physical problems for wildlife resulting from ingestion or enlargement in plastic, the leaching of chemicals from plastic products and the potential for plastics to transfer chemicals to wildlife and human (Thompson *et al*, 2009). Millions of animals (fishes, birds and mammals) are killed by plastics every year. Nearly 700 species, including endangered ones, are known to have been affected by plastics. Most of the deaths to animals are caused by entanglement or starvation (Rustagi,2011).

Plastics are contained many chemical and hazardous substances such as Bisphenol-A (BPA), thalates, antiminitroxide, brominated flame retardants, and poly- fluorinated chemicals etc. which are a serious risk factor for human health and environment (Halden 2010). There are considerable adverse effects of these chemicals on wildlife and humans (Meeker *et al.*, 2009). Different human health problems like irritation in the eye, vision failure, breathing difficulties, respiratory problems, liver dysfunction, cancers, skin diseases, lungs problems, headache, dizziness, birth effect, reproductive, cardiovascular, genotoxic, and gastrointestinal causes for using toxic plastics. Plastics occur serious environment pollution such as soil pollution, water pollution, and air pollution. Application of proper rules and regulations for the production and use of plastics can reduce toxic effects of plastics on human health and environment. Although plastics are known to be low-cost, resilient, and long-lasting, the resultant high levels of plastic waste generation by humans (Hammer *et al.*, 2012) have made its use a universal concern.

Plastic pollution is the accumulation of plastic objects and particles (e.g. plastic bottles, bags and microbeads) in the environment that adversely affects the biodiversity. Plastics that act as pollutants are categorized into micro-, meso-, or macro debris, based on size. The chemical structure of most plastics renders them resistant to many natural processes of degradation and as a result they are slow to degrade. Together, these two factors have led to a high prominence of plastic pollution in the environment. Thus, Plastic pollution has become one of the most pressing environmental issues and becomes the headlines over the past few years.

Distribution of plastic waste is associated with human populations. Increase in human population has led to increase demands for plastics and plastic products. Indiscriminate disposal of plastics waste can lead to environmental pollution which is evident in several ways including deterioration environmental natural beauty (Andrady,2003),entanglement and death of aquatic organisms, sewage system blockage in towns and cities especially in developing countries (Adane and Muleta, 2011), resulting in creating conducive environment for mosquitoes breeding and other disease causing vectors, reduction in water percolation and normal agricultural soils aeration thus causing reduced productivity in such lands (Njeru, J., 2006).

Phthalates or phthalate esters are esters of phthalic acid mainly used as plasticizers (substances added to plastics to increase their flexibility) in Poly Vinyl Chloride (PVC). PVC is a widely used material, including extensive use in toys and other children's products such as chewy teethers, soft toys including medical devices, food packaging, perfumes, cosmetics, flooring materials, computers and CDs and can represent a significant content of the plastic. Di (2-ethylhexyl phthalate (DEHP), dibutyl phthalate (DBP), di-isononylphthalate (DINP), di-isodecyl phthalate (DIDP), benzyl - butyl - phthalate (BBP) and di-n- octyl- phthalate (DNOP) are phthalates mainly used in converting polyvinyl chloride (PVC) from a hard plastic to a flexible plastic. Phthalates migrate into the air, into food and into people including babies in their mother's wombs. Phthalates can be released from soft PVC by surface contact, especially where mechanical pressure is applied. Release of phthalates during manufacture, use and disposal of PVC

products, in addition to their use as additives in ink, perfumes etc. has led to their ubiquitous distribution and abundance in the global environment (Rustagi,2011).

- Different additives used in plastic production and their effects. Halden (2010)

Additives	Uses	Effect on Public health
Bisphenol A (BPA)	Plasticizers	Can liner Mimics oestrogen, Ovarian disorder
Phthalates	Plasticizers,	Artificial fragrances Interference with testosterone, sperm motility
Persistent Organic Pollutants (POPs)	Pesticides, flame retardants, etc.	Possible neurological and reproductive damage
Dioxins	Formed during low temperature combustion of PVC	Carcinogen, interferes with testosterone
Polycyclic aromatic hydrocarbon (PAHs)	Use in making pesticides	Developmental and reproductive toxicity
Polychlorinated biphenyls (PCBs)	Dielectrics in electrical equipment	Interferes with thyroid hormone All plastics
Styrene monomer	Breakdown product	Carcinogen, can form DNA adducts

Polystyrene	Nonylphenol Anti-static, antifog, surfactant (in detergents)	Mimics oestrogen
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- Effects of plastic on the environment:

Substantial quantities of plastic have accumulated in the natural environment. Around 10% by weight of the municipal waste is plastic (Barnes *et al.*, 2009). Discarded plastic also contaminates a wide range of natural terrestrial, freshwater and marine habitats, with newspaper accounts of plastic debris on even some of the highest mountains. An estimated 8 million tonnes of plastic is yearly released into the ocean, leading to degradation of marine habitat which eventually affects aquatic organisms. There are accounts of involuntary contamination of soils with small plastic fragments as a consequence of spreading sewage sludge (Zubris and Richards, 2005) and of plastic being carried into streams, rivers and ultimately the sea with rain water and flood events (Thompson *et al.*, 2005). Phthalates migrate into the air, into food and into people including babies in their mother's wombs. Phthalates can be released from soft PVC by surface contact, especially where mechanical pressure is applied. Release of phthalates during manufacture, use and disposal of PVC products, in addition to their use as additives in ink, perfumes etc. has led to their ubiquitous distribution and abundance in the global environment (Rustagi, 2011).

Human population in certain areas also plays a large role in this plastics pollution and can also be used as vectors for chemical contaminants such as persistent organic pollutants and heavy metals (Barnes *et al.*, 2009). Toxic chemical release during manufacture is another significant source of the negative environmental impact of plastics. A whole host of carcinogenic, neurotoxic, and hormone disruptive chemicals are standard ingredients and waste products of plastic production, and they inevitably find their way into our ecology through water, land, and air pollution. Some of the more familiar compounds include vinyl chloride (in PVC), dioxins (in PVC), benzene (in polystyrene), phthalates and other

plasticizers (in PVC and others), formaldehyde, and Bisphenol-A, or BPA (in polycarbonate). Many of these are persistent organic pollutants (POPs) some of the most damaging toxins on the planet, owing to a combination of their persistence in the environment and their high levels of toxicity. Their unmitigated release into the environment affects all the living organisms which come into contact. The manufacturing process of plastic products in plastic industries releases a huge quantity of dangerous gaseous chemicals into the air including carbon monoxide, dioxin, and hydrogen cyanide. The presence of these gases in air at high proportion is detrimental to both human and animal health. They may cause respiratory diseases, nervous system disorders and reduction in immunity to diseases. Chlorinated plastic can release harmful chemicals into the surrounding soil, which can then seep into groundwater or other surrounding water sources and also the ecosystem. The microorganisms involved in biodegradation of plastics break down the nylon and during broken down, methane gas is released, which is an important greenhouse gas that contributes significantly to global warming (Biello and David, 2011). We are also facing a serious problem of water pollution by plastic waste. Very often we dispose of discarded plastic products in different water bodies including lakes, rivers, ponds, etc. The lakes, bank of rivers and sea beach are the best example of plastic pollution because the plastic bottles, canes, bags and other plastic products were frequently thrown by the visitors. The presence of plastic wastes in water bodies disturbs the natural flow, limits the ability of fish to reproduce and destroys helpful organisms.

- Effects of plastic on Animals:

Animals are exposed to plastic wastes majorly through ingestion and entanglement; however, ingestion is more frequent than entanglement. Reports have shown that more than 260 different species of animals ingest plastics or are entangled by plastic or plastic products, with more than 400,000 deaths of marine mammals (Eriksen *et al.*, 2014). Ingestion of plastic wastes is capable of causing obstruction and physical damage to animal's digestive system, reduce the digestive ability of the system leading to starvation, malnutrition and eventually, death. Many birds, turtles, fishes, seals and other marine animals have died by drowning or

suffocation as a result of entanglement in plastic debris.

Animal entanglement by plastic debris also contributes to death from predators, as the animals are unable to untangle themselves and escape (Hammer, 2012). Coral reefs have been damaged by dragging nets and other plastic products along sea beds (Gregory, 2003).

Microplastics have been found in more than 100 aquatic animal species, including fish, shrimp, and mussels destined for our dinner plates. In many cases, these tiny bits pass through the digestive system and are expelled without consequence. But plastics have also been found to have blocked digestive tracts or pierced organs, causing death. Stomachs so packed with plastics reduce the urge to eat, causing starvation. Plastics have been consumed by land-based animals, including elephants, hyenas, zebras, tigers, camels, cattle, and other large mammals, in some cases causing death.

- Effects of plastic on human health:

Human health risks from plastics can stem from their monomeric building blocks (e.g., Bisphenol A), their additives (e.g., plasticizers) or from a combination of the two (e.g., antimicrobial polycarbonate) (Rahman and Brazel, 2004). There are several toxic materials which are secreted by plastics. Among them, Bisphenol A and phthalates are most important and widely used components. Bisphenol-A (BPA) is best known as the monomeric building block of polycarbonate plastics and used frequently as an additive to other plastics such as polyvinyl chloride (PVC) (Dodds and Lawson, 1936). BPA is often added to plastics to make them more durable. The annual output of BPA in the worldwide was 2.2 million metric tons in 2003. BPA molecules can be released from beverage and food containers into drink and food over time. The leaching process is accelerated by repeated washing of containers and when storing in the acidic or basic items that break down the polymer. As a result, reusable water bottles, baby bottles, and the inner linings of food cans, all made by using BPA, are known to leach the controversial monomer into food over time, particularly at elevated temperatures (Raloff, 1999; Kang *et al.*, 2003).

Food and inhalation are considered the main source of exposure to BPA in the human body (Wilson *et al.* 2007). BPA is known to disrupt hormones and can mimic the effect of reproductive hormones 'estrogen' in the body, leading to weight gain and hormone imbalance. BPA affects gene expression related to the thyroid hormone axis, which affects biological functions such as metabolism and development. BPA can decrease thyroid hormone receptor (TR) activity by increasing TR transcriptional co repressor activity. This then decreases the level of thyroid hormone binding proteins that bind to tri-iodo thyronine. By affecting the thyroid hormone axis, BPA exposure can lead to hypothyroidism. BPA can disrupt normal, physiological levels of sex hormones. It does this by binding to globulins that normally bind to sex hormones such as androgens and estrogens, leading to the disruption of the balance between the two. BPA can also affect the metabolism or the catabolism of sex hormones. It often acts as an antiandrogen or as an estrogen, which can cause disruptions in gonadal development and sperm production (Mathieu *et al.*, 2014). Thus BPA has been associated with a number of health problems such as ovarian chromosomal damage, decreased sperm production, rapid puberty, rapid changes in immune system, type-2 diabetes, cardiovascular disorder, obesity etc. Some studies have also claimed that BPA increases the risk of breast cancer, prostate cancer, pains, metabolic disorders, etc.

Phthalates or phthalate esters are esters of phthalic acid, a compound also known as 1, 2-benzenedicarboxylic acid and used as plasticizers in Poly Vinyl Chloride (PVC). PVC is a widely used material, including extensive use in toys and other children's products such as chewy teethingers, soft toys including medical devices, food packaging, perfumes, cosmetics, flooring materials, computers and CDs and can represent a significant content of the plastic. Di (2-ethylhexyl) phthalate (DEHP), produced at annual quantities of 2 million tons and usually work to increase plastic flexibility or flexibility. These are widely used in medical devices. The European Union banned them in 2005 and many other countries have banned them as well. Important routes of human exposure to phthalates include, most notably, medical exposures caused by direct release of phthalates into the human body, e.g., through dialysis, blood

transfusions, and extracorporeal membrane oxygenation (ECMO); ingestion of contaminated materials, including contaminated food, house dust etc. (Sathyanarayana, 2008; Kamrin 2009; Meeker *et al.* 2009). Phthalates are considered to be especially harmful to men and boys, especially those exposed in utero. They are linked to immune system impairment, reduced testosterone, infertility in men and many other problems (Dr. Edward, 2015).

Phthalates like BPA also act as hormones disrupter but it is less damaging to human than the BPA. Both BPA and phthalates can enter the body of the newborn through pregnancy and through fetal and breast feeding; they will be able to harm them. There is also now abundant research that links BPA and phthalate exposure to such human health concerns as deformities of the male and female genitals; premature puberty in females; decreased sperm quality; and increases in breast and prostate cancers, infertility, miscarriages, obesity, type-2 diabetes, allergies and neurological problems, like attention deficit hyperactivity disorder.

- Plastic waste management and Regulation of Plastic industry in India:

With the growth of Small Scale Industries (SSI) in India, plastic processing and reprocessing industries also began in the decade of eighties. Policy instruments adopted by the Government to encourage the growth of SSI industry of rubber and plastic products, which are declared as reserved products constitute 4.6% of the total number of SSI units, generate 5% of employment in SSI and has 8.4% of investment (Pain,1990). Among many advantages, these industries have lower excise duty on the final products and are free from the tiresome procedural formalities. A plastic recycling unit needs to have a power point passed by the local electricity board at the least. Registration with Industrial Development Corporation is not mandatory. Most of these are having less than 5-7 employees and cannot be covered under labor law. Plastic processing and reprocessing industries are also exempted from monitoring by Pollution Control Board (Shah, 1997).

With regard to safety guidelines for toys in India, Bureau of Indian Standards (BIS) has published three standards which deals with safety aspects of toys

related to mechanical and physical properties, flammability requirements and migration of certain elements (limiting heavy metals in toys). None of these standards give limits for phthalates in children's toys and child care articles. The BIS guideline with regard to toy production is self-regulatory and not mandatory. Toy manufacturers do not register even for the ISI mark for their products and therefore do not follow even the voluntary standards.

Regulation of plastics waste, particularly manufacture and use of recycled plastics carry bags and containers is being regulated in the country as per “Recycled Plastics Manufacture and Usage Rules”, 1999 and as amended in 2003. This has now been replaced by Plastic Waste (Management and Handling) Rules, 2011. Some of the salient features of the new Rules are:

- ban on use of plastic materials in sachets for storing, packing or selling gutkha, tobacco and pan masala,
- no food stuffs will be allowed to be packet in recycled plastics or compostable plastics,
- recycled carry bags to have specific BIS standards, colour to the prescription by the Bureau of Indian Standards (BIS),
- Uniform thickness shall not be less than 40 microns in carry bags etc.

In reducing toxic effects of plastic wastes on the environment and public health, waste management plays an important role. For global reduction of plastic pollution, there is need for improvement in proper plastic waste collection, treatment and disposal. Inadequate management of landfills will make way for harmful chemicals in plastic wastes to leach into the environment, polluting the soil, air and underground water. Proper wastewater management will prevent microplastics from entering the environment from the landfills.

Efforts must be made to educate the general people on the potential environmental and public health effect of pollution by plastic wastes. This will go a long way to reduce the pollution rate and preserve the quality of the environment. There is need for people to be aware of the chemical constituents of plastic products and their health effects. Educational curriculums at

different levels must include ways of plastic pollution reduction and waste management systems as information resources.

Municipal or Government authorities and NGOs may play crucial role in recognizing and legitimizing both plastic waste recovery and trading activities and equipping them with state of art designs of waste management technology and system. Developing safe and low-cost technology for which SSIs need institutional and scientific support and making mandatory of guidelines related to safety, process and product standards in consultation with plastic associations are one of the few ways. The Municipal authority under new rules is hold responsible for setting up, operationalization and coordination of the waste management system and for performing the associated functions, This will include ensuring safe collection, storage, segregation, transportation, processing and disposal of plastic waste, no damage to the environment during this process, setting up of the collection centers for plastic waste involving manufacturers, its channelization to recyclers, to create awareness among all stakeholders about their responsibilities, and to ensure that open burning of plastic waste is not permitted.

CONCLUSION

Despite the fact that plastics are very useful in everyday life, the toxic chemicals used in its production need to be thoroughly monitored so as to ensure environmental and health safety. Reducing community's exposure to toxicants released from plastic wastes will increase the chances of having a clean environment and severer adverse health outcomes such as cancer, birth-defects, impaired immunity, endocrine disruptions, reproductive effects etc. so there is an urgent need to find options or substitutes of plastics and their safe disposal to avoid health hazards in future and also to maintain the ecological balance of our country. There is a urgent need for government agencies and health authorities to enact and enforce environmental laws that will monitor production, usage and disposal of plastics. In addition, some harmful chemical constituents used in the production of plastics (e.g. phthalates, BPA, etc) should be banned in consumer goods and in plastic

products that are in direct contact with food, beverages and children.

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