

REVIEW ARTICLE

Effect of Plastic on Human Health

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ABSTRACT

Plastic has become a ubiquitous material since its discovery in 1950s. Plastic has become a part of our life. In our daily routine life, we use plastics like tooth brush, bucket, mug, kitchen containers, water bottles and the list go on. Its nearly impossible to go through a day without coming across any kind of plastic. A number of plastics are used to store food, deliver or serve foods and drinks. Although FDA (food and drug administration) discreetly try to review the manufacturing of these plastics that they aren't harmful in any way to the human and environment, but still there are evidences and researches related to the toxicity of plastic inside human body. Toxicity is the ability of an agent to cause injury. It may not be seen as a much big issue but indeed it is topic to ponder upon by the general public to check the quality of the plastic, we are using in our day-to-day life or is it safe to reuse the plastic again and again. We need to know about the guidelines given by the 'Bureau of India standard' relating to proper use of the recycled plastics, the type of plastic which is safe to use, their toxicity and harmful effect and what safety measures we can take to minimize its hazardous effect on us. And the researches which clearly show that microplastics are capable of entering our body.

Key Words *Plastic, Toxicity, Microplastic, Polymer, FDA*

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INTRODUCTION

Plastics are a wide range of synthetic or semi synthetic materials that use polymers as a main ingredients¹. Word plastic does not define a single entity or a single substance. Plastic is a polymer which etiologically stands for 'many parts', and support the fact that it is not only a type of plastic but there is a entire family of types of plastic we use in our daily routine starting right from the waking up early in the morning, in between and going to bed at night. Whether it is the bottle we drink water from or the polybags we use to carry

our stuff or to store and pack our food in plastic containers, enormous number of instances related to its use are present all around us. It was a boon for our society when it first came in existence in 1950's but rather has become a bane for human health. Toxicity is the ability of an agent to cause injury². And plastic toxicity is still a subject of exploration. The per capita consumption, however, has been low at 11 kg per annum, compared to the global average of 28 kg. Among developed nations, the US has a per capita consumption of 139 kg per annum, while the

REVIEW ARTICLE

EU's is 65 kg. What is alarming is that per capita consumption of plastic products in India is rising – it is expected to go up to 16-20 kg per annum by 2025³.

In fiscal year 2020, the production volume of performance of plastics across India was around 1.7 million metric tons⁴.

Even though it is one of the most used materials in daily life, its health impact on human health is insufficiently understood. We all are well acquainted with its use on daily use. But really not well aware of the toxic threat it poses because not many research studies are conducted.

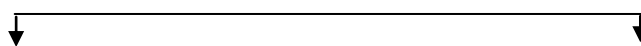
Plastic is a versatile material. It is the main building block for making a variety of things, one of which is its use in the food packaging industry. They are so durable and light weight which

makes their shipping easier. It helps to protect food from damage and deliver the food safely. It also helps to maintain the freshness of food. It is used in the packaging of food, beverages, water, processed food and many more.

It is used because of their resilience, cost effectiveness and easy availability. Based on the type of food material we are going to store in these plastics, they can be of different material combination and can be graded differently according to their use like polyethylene terephthalate (PET), polypropylene (PP), poly vinyl chloride (PVC), polystyrene (PS), etc.

While we are considering the human health effects of the plastic, its toxicity can be differentiated in two categories:

PLASTIC TOXICITY EFFECTS



Plastic particles entering our body

Chemical additives, & Plasticizers

Types of plastic grading

In Indian Government plastic grading is stated in Indian standard: IS 14534: 1998 titled as “Guidelines for recycling of plastics” amended from time to time⁵. It is numbered from 1-7 inside a recycle sign near the bottom of bottles and containers. It also known as Resin Identification Coding System is explained below.

TYPE 1: PET (Polyethylene terephthalate)

It is the most frequently used plastic used in disposable food and drink containers. It is commonly used packaging material for many

food products, beverages like bottled water, carbonated soft drinks and fruit juices⁶. It's because of their inherent properties that it is well suited for lightweight, large capacity and shatter resistant containers⁷. Due to its rigidity and glass like transparency, it is widely used as food packaging material with identification of code⁸. This type 1 plastic is frequently used in packaging of food, soft drinks, single serve water, ketch up, vegetable oil bottles, fruit juices, jams, trays etc.

TYPE 2: HDPE (High density polyethylene)

REVIEW ARTICLE

HDPE is one of the safest plastics. It is hard and opaque plastic that is light weight but also strong. It is generally used in packaging of juice, milk jugs, vinegar bottles, chocolate syrup and in grocery bag

TYPE 3: PVC (Polyvinyl Chloride)

The element chlorine is the primary constituent that is used in manufacturing of polyvinyl chloride. It is common type of plastic that is biological and chemical resistant.

It is used in packaging of tamper resistant over the counter medications, as well as shrink wrap for various products. Also used in blister packaging such as in packaging of breath mints or gum.

TYPE 4: LDPE (Low Density Polyethylene)

It is thinner than some other resins and also has high heat resilience. It is commonly used to make coffee can lids, bread bags, as well as fruit and vegetable bags used in grocery stores.

TYPE 5: PP (Polypropylene)

It is slightly stiff but less brittle than other plastics. It can be made translucent, opaque or different color when it is manufactured. It generally has a high melting point which make it suitable for food packaging products that are used in microwave or can be cleaned in dishwashers.

It is used as a material in manufacturing of microwave dishes, ice cream tubs, potato chips bag and straws.

TYPE 6: PS (Polystyrene)

It is a colorless, hard plastic without much flexibility. It can be made into foam or cast into molds and given fine details in shape at the time of manufacturing, for example into the shape of plastic spoons or forks.

It is used to make plastic cups, bakery trays, fast food containers lids, egg cartons etc.

TYPE 7: Other

It directs that the packaging is made with a plastic resin other than the six types of resins listed above. It can be polycarbonates (PC), acrylonitrile butadiene styrene (ABS), polybutylene terephthalate (PBT), polypropylene oxide, bisphenol-A(BPA)etc.

It is commonly found in baby bottles, CDs, nylon etc.








Plastic particles-based toxicity

It is the kind of toxicity which enter our body through inhalation or ingestion of microplastic or nanoplastic particles. Microplastic is a term for plastic particles for which no universally established definition exist. Microplastic is often defined as plastic particles up to 5mm in dimensions with no defined lower size limit. Nanoplastic is a term for plastic particles in the submicron range, $<1\mu\text{m}^9$.

Till date most of the research on the impacts of micro- and nanoplastic particles has focused on impacts to marine life, while their impacts on human health have received much less attention¹⁰.

REVIEW ARTICLE

Table 1 “Types of Plastic Grading”

TYPE OF GRADING SYMBOL	POLYMER NAME	PRODUCTS
	Polyethylene terephthalate	Soft drink bottles, water bottles, sport drink bottles, vegetable oil bottles, pickle jars, prepared food tray
	High density polyethylene	Juice and milk jugs, vinegar bottles, chocolate syrup, shampoo bottles,
	Poly vinyl chloride	Blister packaging like breath mints and gums, Flooring, drainage pipes, window profiles, seals, tubes, records, baby products, swim rings
	Low density polyethylene	Plastic bags for dry-cleaning, newspapers, bread, frozen foods, fresh produce and garbage
	Polypropylene	Food packaging, electrical household appliances, automotive parts, construction, garden furniture, artificial lawns, suitcase shells, medical appliances, plastic bags
	Polystyrene	CD jewel cases, electric cable insulation, casings for electrical appliances, yoghurt containers, packaging foils, thermal insulation, insulating packaging material.
	Polycarbonates, Bisphenol A etc	Water bottles, baby bottles, tableware, and food storage containers.

There is a promising data indicating the existence of micro and nano particles of plastic in the food we eat, air we breathe and water we drink, which definitely raise concern to human health. It can affect renal, cardiovascular, gastrointestinal,

neurological, reproductive and respiratory systems; impacts include cancers, diabetes and developmental toxicity¹¹.

A new study published recently found out that half of blood samples contained traces of PET

REVIEW ARTICLE

plastic which is commonly used in water bottles and Polystyrene, used in food packaging and other stuff. The research concluded the data that supports the hypothesis that human exposure to plastic particles results in absorption of particles into the bloodstreams¹².

A similar study which was conducted with frequent use of tea bags concluded that a single plastic tea bag at brewing temperature (95°C) releases approximately 11.6 billion nanoplastic into a single cup of beverage which support the fact that tea bags are the composition of Nylon and Polyethylene terephthalate¹³.

Plasticenta a term given to evidence of microplastic in human placenta. This research sheds new light on the level of human exposure to microplastics. Due to crucial role of placenta in supporting the fetus and in acting as an interface between the latter and external environment, the presence of exogenous and potentially harmful particles is a matter of great concern¹⁴.

In a study, microplastics presence was revealed in human lung tissues obtained at autopsies. The most frequently determined polymer was polyethylene and polypropylene¹⁵.

All these researches are clear indication of plastic ingestion or inhalation on daily basis.

Plasticizers & chemical additives toxicity

A wide array of chemicals additives are used in the manufacturing process to create a polymer, including initiators, catalysts, and solvents¹⁶. And plasticizers can be understood as a part of chemical additives added to a synthetic resin to

produce or promote plasticity, flexibility and to reduce brittleness e.g., bis(2-ethylhexyl) phthalate, glycerol, citrate, BPA, antimony, styrene etc. Most of used additives are not tightly bound to the polymer matrix, due to their low molecular weight, so they are easily leached out of the polymer¹⁷.

Antimony

Antimony is used as catalyst in the production of PET bottles. It is potential cancer-causing agent which can enter human body. If water is stored in the bottle for a longer time, the possibility of antimony discharge increases leading to dermatitis, irritation in respiratory tract, changes in ECG & gastritis in humans¹⁸.

The available research suggests that the concentration of phthalates varies according to function of the contents of the bottle, with phthalates leaching into lower pH products such as soda and vinegar more readily than into bottled water¹⁹.

Temperature also influences, the leaching of phthalates & antimony from PET, with greater leaching at high temperature²⁰.

Bisphenol A (BPA)

It is a main element in the manufacturing of polycarbonate. It is found in many plastics and resins and in products ranging from infant bottles to water pipes. BPA has structure similarity with estrogen. The chemical often called as endocrine disruptor because of its ability to alter hormone activity²¹.

It is an antagonist of the thyroid hormone receptor and poses anti androgenic properties²².

REVIEW ARTICLE

In an experiment study BPA was found which migrates from polycarbonate baby feeding bottles on an average value 19ng/ml to hot water at 70-degree celsius²³. A study conducted on the impact of bisphenol A on children, it was found that gestational BPA exposure affects the behavioral and emotional regulation domains at 3 years of age, especially among girls²⁴. There is a research study which has linked BPA to depression and anxiety among the boys²⁵.

Phthalates

Phthalates are added to plastics to increase its flexibility, transparency, durability & elasticity. They are added on the top sheet and outer sheet to provide the flexibility and elasticity to the disposable diapers so that it can easily stretch to provide comfort to the baby²⁶. Researches have inferred that as diapers are in direct contact with the skin of babies for a longer period so there is a probability that significant amount of phthalates could be absorbed into the reproductive system through the skin²⁷.

Preventive measures

Use of plastic can never be wiped out completely, only some safety measures can rule out the entry of the plastic inside our body. And some points that we need to be aware of while using plastic.

1. To sum up, plastics in categories of TYPE 2, 4, 5 are generally consider safe. TYPE 1, 3, 6, 7 are not consider due the hazards it poses to human health and should be used with care, specifically around food and drinks.

2. We should use PET onetime only as it got a porous structure so we need strong cleaning

products. These products can cause carcinogenic leach.

3. Avoiding baby bottles which does not mention BPA free.

4. Do not use PET bottles for storing of water. Copper or stainless steel should be considered to store water.

5. Use glass or ceramic bowls to heat food or drinks in the microwave.

6. Let food cool to room temperature before putting it into plastic storage containers.

Various actions have been taken by the Government in restricting the use of the plastic which may poses some hazard to human health:

FDA has amended its regulations to no longer provide for the use of BPA based polycarbonates resins in the baby bottles and Sippy cups in July 2012²⁸.

FDA has amended its regulation to no longer provide for the use of BPA based epoxy resins as coatings in packaging for infant formula in July 2013²⁹.

Bureau of Indian Standard has revised the standard for baby feeding bottles in 2015 as per IS14625:2015 & prohibited the use of BPA in baby feeding bottles³⁰.

Indian Standard “GUIDELINES FOR RECYCLING OF PLASTIC” IS: 14534:1998 While marking the symbol 7, the respective basic raw material like ABS, PPO, PC, PBT, etc, and mixed shall be indicated below the symbol³¹.

In addition to the resin identification codes being indicated, the end product made out of recycled/reprocessed plastics, wherever possible,

REVIEW ARTICLE

shall be marked with 'Recycled indicating percentage of use of recycled material'³².

However, carry bags/containers made out of recycled plastics shall be labeled as 'Not suitable for packing/storing/carrying food products'³³.

DISCUSSION

It can be clearly seen that indeed plastic is toxic to us. Although it's not like those acute cases can be observed in daily life. But rather it might be concerned with chronic toxicity which is further an area to be explored.

Still a lot of research needs to be conducted to explore the health hazard of plastic in humans. Although Government of India has taken initiatives to implement single use of plastic from July 2022 which is mainly concern with the plastic waste management and keeping environment clean³⁴. This may be an indirect way to stop plastic to enter in food chains. Indian Standard "GUIDELINES FOR RECYCLING OF PLASTIC" clearly states that while marking the grading symbol 7, respective basic raw material should be clearly indicated below the symbol but which is clearly not seen in many plastic products. People need to be aware of these minute details for better avoidance of plastic inside our body. Currently at present selectively few researches are there which shows the presence of microplastics in human blood, which further requires a lot of exploration of its affect in human³⁵. A lot of findings are already there to establish the toxic effects of plastic in

environment and marine animals, which clearly indicates the lack of awareness of plastic toxicity in human beings and why it hasn't been explored much. Plastic is not degraded easily in the environment and that's why a huge pile of plastic waste can be observed. People dump plastic and burn plastic in the surroundings even being aware of the consequences they may face in the future due to indirect entry of plastic particles inside us and we don't know yet how they can affect our cells cytotoxicity. Studies presents the detection of microplastics in human lung tissue which further require cytotoxicity research to establish the fact that health consequences can be associated with microplastic inhalation. We really need to conclude the fate of microplastics inside our body. We need to know if somehow, they are capable of causing autoimmune diseases which is a major concern in present. A lot of thorough studies and research are required to prove these kinds of hypothesis.

CONCLUSION

Since its discovery plastic utilization in our everyday life has been ever increasing considerably than being declined. Now it is a matter of our awareness to take enough measures with its regular use. Its use in our lives can never be lowered to zero but to some adequate amount. It is known to cause endocrinal disrupt and affect every system of our body. Its effects are not present so widely and clearly which doesn't mean that if it is not visible, does not deny the fact of

REVIEW ARTICLE

its existence. Current dataset provided by the research which supports the hypothesis that human exposure to plastic results in their absorption of particles into the bloodstream³⁴. And if plastic particles are present in bloodstream, how they travel inside our body is still a subject of further research which is roughly postulated as microplastic may act as antigen for human immune system, chances are that they may attach themselves to immune cells. But as stated, it is still under research how they may act with immune system or if they get deposited inside our body. Till then nothing can be said clearly and simply is a part of hypothesis and learn to live cautiously with it.

REVIEW ARTICLE

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REVIEW ARTICLE

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