
**ISSN Print:** 2394-7500
**ISSN Online:** 2394-5869
**Impact Factor (RJIF):** 8.4
IJAR 2025; 11(1): 134-137
www.allresearchjournal.com
Received: 17-11-2024
Accepted: 23-12-2024

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# A review on micro and nano plastics: A rising concern as food contaminants

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**DOI:** https://doi.org/10.22271/allresearch.2025.v11.i1b.12270

**Abstract**
Micro and nano plastics (MNPs) are rapidly becoming a global concern as pollutants in the environment due to the risks that they pose to food safety and human health. As particles with a size of below 5mm (microplastics) and 1µm (nanoplastics) in size, MNPs are derived from many sources such as the breakdown of larger plastic waste, synthetic textiles, personal care products, and industrial operations. Research done on MNPs shows that the particles are common in water bodies with reported concentrations of up to 1,700,000 particles per square kilometer in some regions of the seas. These particles have increasingly been found in food products including seafood, freshwater fish, salt, honey, and bottled water amongst others, current investigations indicate that an individual may intake tens of thousands of microplastic particles per year.
Some of the health effects that arise from MNP ingestion are as follows. Based on *in vitro* studies, it has been revealed that MNPs may cause inflammatory reactions, oxidative stress, and possible endocrine disruption in animals. Besides, they can capture hazardous substances like POPs and heavy metals, which may be transported into the human digestive system and increase the chance of negative health consequences. Nevertheless, based on the presented results, current regulation appears insufficient to tackle accomplished issues in MNP contamination and thus requires usage of new approaches for detection and thorough evaluation of potential risks.
This review brings together existing information on sources, routes of exposure, and possible effects of MNPs on human health in the food chain. In particular, it highlights the need for the creation of cooperative international laws as a measure of dealing with MNP contamination and improving the population's health.

**Keywords:** Microplastics, nano plastics, food safety, contaminants, human health, toxic chemicals

## Introduction
In the present situation of plastic pollution, as the use of plastics is multiplying by leaps and bounds because they are versatile, cheap, and long-lasting, it has also raised environmental issues. Unfortunately, it is the great durability that makes these plastics so essential due to the fact that they have a way of staying around in the environment. Dependencies show that all large plastics will ultimately transition to become MPs and NPs due to various weathering factors. Microplastics smaller than 5.0 mm and 1.0 µm refer to the breakdown of larger plastic or 'micro-beads' that are intentionally used in items such as cosmetics, and industrial applications.
It may be observed that the importance of plastic contamination in food is increasing day by day. In ecosystems, MPs and NPs have been invading waters, and consequently, food products have been recorded containing microplastics, a fact that poses a threat to food safety and health. Investigations show that these pollutants can bring dangerous compounds into the human body and can cause several diseases, including endocrine interference and inflammatory processes. Furthermore, there are some deficits in the coherent legal requirements for governing MNPs which complicate the problem and require the attention of policymakers. Consumers are relatively unaware of the problems related to plastic contamination within food and this simply establishes the importance of creating awareness and informing the consumer on the negative impacts of using MNPs.
This review plans to provide an updated review of the trends of microplastics and nanoplastics as food-binding agents and possible health consequences.

In this work, an attempt has been made to draw from prior scholarship to enhance the comprehension of this critical matter as well as review the barriers faced by regulators together with enlightenment provided to the general populace on the potential effect of microplastics on food safety and health of people.

**Applications of Microplastics and nanoplastics in Food**

MPs are plastic debris less than 5 mm in size and NPs are in the dimension of 1 - 1000 nanometers in size (Figure 1). Microplastics are usually described as particles with dimensions below 5mm, with nanoparticles being particles with dimensions of less than 1µm (Gigault *et al*., 2016) [3]. They can be primary which are directly produced in a small size or secondary which are evolved due to the breakdown of larger plastic objects (Andrady, 2011) [1]. With regards to the impacts of NPs on the environment and biological health, nanoplastics are more difficult to measure and have different effects. Still, MPs and NPs are non-degradable and can accumulate in different ecosystems as well as in food chains.

**Fig 1:** Microplastics

Sources of MNPs in the environment are through various human activities industries activities and industrial processes. The first type of microplastic source is derived from the fragmentation of larger plastic debris by abrasion, leaching, and biodegradation. This comprises bottles, bags, and packaging materials that disintegrate into micro elements due to factors such as ultraviolet light, mechanical shear, and heat among others. Another source of microplastics is also the washing of synthetic textiles that have been produced industrially (Browne *et al*., 2011) [2].

However, compared to microplastics, nanoplastics have been studied insufficiently, and their sources could be further degradation of microplastics, industrial abrasives, and other consumer products such as cosmetics. Nanoplastics can be more dangerous as they penetrate biological membranes more easily because of their size, yet their effects are still unknown (Gigault *et al*., 2016) [3].

**Classification as Contaminants**

Microplastics and nanoplastics are informed under the contaminants within food because they are resistant to the environment and cause risks to human beings. Unlike biodegradable particles, MNs remain in the ecosystem as they seep into water bodies reach the soil and air, and finally find their way into food that is eaten by man. The understanding of MNPs as contaminants stems from studies that show that these plastics act as carriers of hazardous chemicals including POPs, heavy metals, and additives into peoples' plates. These particles when consumed pose various risks to the body's health such as inflammation, oxidative stress, and endocrine disruption.

**Prevalence of Microplastics and nanoplastics in Food Products**

Some current investigations have found that microplastics and nanoplastics are present in a broad array of food items, and therefore the extent of human exposition has been put into question. MNP bioaccumulation also occurs in other foods of animal origin, particularly in seafood, such as mussels and oysters which are regarded as filter-feeding organisms. Research done in European countries showed that on average mussels had between 0.36 to 0.47 microplastic particles per gram of muscle tissue. Likewise, fish and shellfish have been found to engulf microplastics in water and these are found lodged in the gastric tracts, gills, and muscles and hence, enter the food chain.

Another important input source of microplastics is bottled water that is consumed by people. Research that focused on 11 kinds of bottled water identified 103 of the 259 samples discovered microplastics that included a mean of 325 particles per lit (Mason *et al*., 2018) [5]. These microplastics are thought to be from the plastic packaging or during the actual bottling of the item. In addition, Kosuth *et al*. (2018) [5] revealed that tap water also includes microplastics but present at a relatively low level, indicating that drinking water sources cannot be spared from plastic pollution.

Another food product that contains microplastics is salt. Different research has shown that different sea salts such as sea salt have microplastics, which are perhaps originating from marine pollution. For instance, one study carried out across the world found that any given kilogram of sea salt contains an average of 550-681 microplastics. Conventionally sourced rock and lake salts which have comparatively low concentrations of pollutants also had microplastic traces thus giving credence to the fact that the problem of microplastics in salts is not restricted to a particular type.

Recent studies also identified the content of MNPs in fruits and vegetables. Research has also shown that produce that is grown with furrows that are supplied with contaminated water or plants that are grown in soil containing plastics may absorb microplastic through their roots. While the quantitative distribution of MNPs in shoot and tuber of plants is still an area popular for further research, it has been discovered that root crops which are a subset of horticulture can transmit polyvinyl chloride intake (Conti *et al*., 2020) [4].

**Health Effects of Microplastics and nano plastics When Consumed in Food**

Consumption of microplastic and nanoplastic particles (MNPs) in food is a relatively new and alarming trend in public health (Fig 2). While there are data and studies about the long-term effects they do not yet indicate that MNs are toxicologically hazardous, they may be in the long run and pose chronic health hazards to one 's health, this is so especially to children, pregnant women, and those with compromised immune systems.

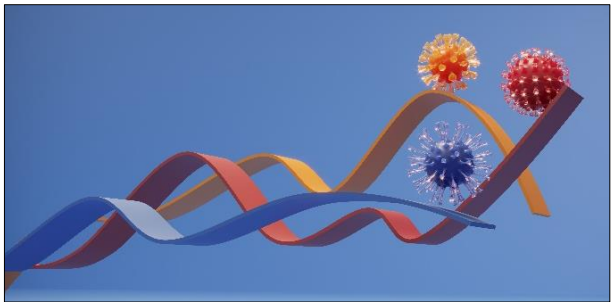

**Fig 2:** Infection

**Toxicological Effects**

Orally administered MNPs can be swallowed and ingested through the gastrointestinal tract and, in certain instances, penetrative biological barriers. These are particulate substances that can become internalized once they are consumed, and may even cause mechanical damage to cells, leading to oxidative stress as well as inflammation. Investigations on animal subjects have shown that MNPs have the potential to produce ROS that could compromise cellular and tissue integrity (Wright & Kelly, 2017) [12]. Chronic inflammation may be precipitated by immune responses resulting from cellular damage.

Furthermore, MNPs can also adsorb toxic chemicals including POPs, and heavy metals that are inadvertently accumulated by these plastics in the surroundings. Once in the body, these substances can dissipate from the MNPs and into human tissues which in turn leads to enhanced toxicological tendencies such as endocrine disruption and carcinogenicity (Rochman *et al*., 2013) [11].

**Long-term Health Implications**

The effects of MNPs in the long term are yet unknown but the research conducted portrays certain threats to the health of the consumers. One of them is endocrine disruption, which means that chemicals related to MNPs such as bisphenol A (BPA) and phthalates affect hormonal imbalance. This may have consequences on the development, of the reproductive system, and metabolic disorders such as obesity and diabetes (Galloway *et al*., 2017) [10].

If they are ingested, MNPs may also cause an increased risk of gastrointestinal tract cancers. While direct evidence is deficient, the bioaccumulation of microplastics in tissues over time suggests that such particles can induce mutation or even enhance tumor formation (Cox *et al*., 2019) [9]. The amount of soot and other particles emitted by these vehicles may be further complicated by the toxic substances collected on the particles.

Children are more vulnerable because their metabolic processes are still rapidly developing and have more vulnerable receptors to hormonal changes and other toxicological effects. Furthermore, children consume more food and water per unit of their body weight than adults and are therefore more exposed to MNPs.

Pregnant women are another vulnerable group, as MNPs could potentially cross the placental Another special population specific to the female gender is pregnant women because MNPs might possibly be transported across the placental membranes affecting fetal development. Such exposure to endocrine-disrupting chemicals such as BPA, can result in developmental disorders and birth defects, where exposure occurs during pregnancy (Campanale *et al*., 2020) [8].

Elderly people, pregnant women, and people with sick or injured immune systems, including gastrointestinal disorders, are also more vulnerable. For instance, patients with chronic inflammatory diseases such as inflammatory bowel disease (IBD) might experience worsened conditions by the inflammatory effect of MNPs.

**Range of Microplastics Allowed by FSSAI**

Due to the pervasiveness of MNPs in the food chain, the issue concerning the safety of food and the health of consumers has arisen. With increasing toxicity levels of MNP's in ecologies the world over, from industry, it comes under pressure to develop rules which can effectively regulate the impacts of these pollutants such as the Food Safety and Standards Authority of India (FSSAI). This section discusses the existing MNP regulations in India and evaluates the corresponding international practices and recommendations to strengthen those perceptions.

**Current Regulations on Microplastics**

At present, FSSAI does not have standard operating procedures or action limits exhaustive to microplastics or nanoplastics in food products. So far, microplastic pollution is dealt with mostly under generalized measures containing rules associated with food legislation, including rules preventing the usage of packaging materials and the presence of chemicals and toxins in the food chain. FSSAI already regulates packaging through packaging materials that are in direct contact with food and the packaging must not transfer food unsafe substances but the rules do not at the moment capture microplastics.

However, the observation of the past few years shows that FSSAI seems concerned with the problem of plastics in the human foods chain, especially after research that established that micro and nanoplastics are present in water, seafood, and other food products. For instance, FSSAI has banned several single-use plastics some of which it has been regulating the phases of extending measures that would help avoid plastic pollution of the food supply chain. Nevertheless, there remain no specific SAFE threshold limits defined for microplastics in adult food, which was determined to constitute a major regulatory deficiency.

**Conclusion**

Microplastics and nanoplastics (MNPs) are emerging contaminants in the global food chain and represent potential threats to safety and health. Studies have indicated that MNPs are incorporated in many different foods such as seafood, salt, bottled water, and even fruits and vegetables. Some of the health impacts observed in consumers of MNP include; cellular oxidative damage, inflammation and endocrine disruption, and carcinogenicity at doses more research needs to be done on the long-term effects. Yet, the FDA along with the help of FSSAI and other control bodies worldwide still does not allow the permissible levels of MNP incorporated into food products, creating a regulatory loophole. For future directions, attention should be paid to further integration of scientific approaches in cooperation with the regulators and representatives of industries. Solutions require enhanced packaging requirements, improved identification technologies, and synchronized global measures. Together, we can step up efforts to reduce

the rising risks associated with MNP contamination so that medication safety, food hygiene, and overall health for people of generations to come will not be compromised. No greater global health crisis than that of making MNP contamination a chronic issue that requires collective effort to reverse its effects.

**References**


1. Andrady AL. Microplastics in the marine environment. Mar Pollut Bull. 2011;62(8):1596-1605. DOI: 10.1016/j.marpolbul.2011.05.030.
2. Browne MA, Galloway TS, Thompson RC. Microplastic - An emerging contaminant of potential concern? Integr Environ Assess Manag. 2011;3(4):559-561. DOI: 10.1002/ieam.5630030412.
3. Gigault J, Halle AT, Baudrimont M, Pascal PY, Gauffre F, Phi TL, *et al*. Current opinion: What is a nanoplastic? Environ Pollut. 2016;215:677-680. DOI: 10.1016/j.envpol.2016.01.024.
4. Conti GO, Ferrante M, Banni M, Favara C, Nicolosi I, Cristaldi A, Zuccarello P. Micro- and nanoplastics in edible fruit and vegetables: The first diet risks assessment for the general population. Environ Res. 2020;187:109677. DOI: 10.1016/j.envres.2020.109677.
5. Kosuth M, Mason SA, Wattenberg EV. Anthropogenic contamination of tap water, beer, and sea salt. PLoS One. 2018;13(4):e0194970. DOI: 10.1371/journal.pone.0194970.
6. Mason SA, Welch VG, Neratko J. Synthetic polymer contamination in bottled water. Front Chem. 2018;6:407. DOI: 10.3389/fchem.2018.00407.
7. Yang D, Shi H, Li L, Li J, Jabeen K, Kolandhasamy P. Microplastic pollution in table salts from China. Environ Sci Technol. 2015;49(22):13622-13627. DOI: 10.1021/acs.est.5b03163.
8. Campanale C, *et al*. A detailed review study on potential effects of microplastics. Int J Environ Res Public Health; c2020.
9. Cox KD, *et al*. Human consumption of microplastics. Environ Sci Technol.; c2019.
10. Galloway TS, *et al*. Interactions of microplastic debris throughout the marine ecosystem. Nat Ecol. Evol.; c2017.
11. Rochman CM, *et al*. Long-term field measurement of sorption of organic contaminants to plastic pellets. Environ Sci Technol.; c2013.
12. Wright SL, Kelly FJ. Plastic and human health: A micro issue? Environ Sci Technol.; c2017.