Micro- and nanoplastics: an environment, food safety and supply threat, a consumer perception study

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Summary

- In this era, a plastic free world is unimaginable, they are ubiquitous, versatile, cheap, convenient and have applications from primary to quaternary industries.
- However, most degrade into microplastic and nanoplastics of dimensions below 5mm and these pose threats to the environment, food safety and supply chain through their toxicity, purveyor of other toxic compounds. entanglement and ingestion.
- The Covid-19 pandemic exacerbated the issue and highlighted the necessity for plastics, as most of the PPE are made of plastics.
- The evidence for direct health implication is sparse. Thus this paper aimed to assess the implied adverse health effect through a critical review of current literature and an online survey which is restricted to a small demography and number (n=72).

- **Keywords:** Microplastics; Nanoplastics; Food safety; Environmental pollution; Consumer awareness; Food Supply

Introduction

- Plastics and subsequently micro-nanoplastics are everywhere, from the USA (McEachern et al., 2019) to Europe (Dris et al., 2017) to Antarctica (Reed et al., 2018) and the Arctic Circle (Fang et al., 2018), to name but a few. They are an inevitable part of human life, from cradle to grave.

- The establishment of plastics as an industry in 1930s (the British Plastic Federation) was a magical global industrial turning point. The happy tale of plastics did not end so well, it has been estimated that by 2050, the ocean will contain about 1 million tons of plastic debris per square mile with 7000 to 35000 tons floating in the open oceans and basins (Rainieri and Barranco, 2019).

- In 2019, an awareness campaign on the extent of the pollution of the sea was made through an artwork which was displayed in some of the national train stations in London (Figure 1). It showed a fish belly-full of plastics and other debris and estimated that 24 kg of plastic is discharged into the ocean every tenth of a second.

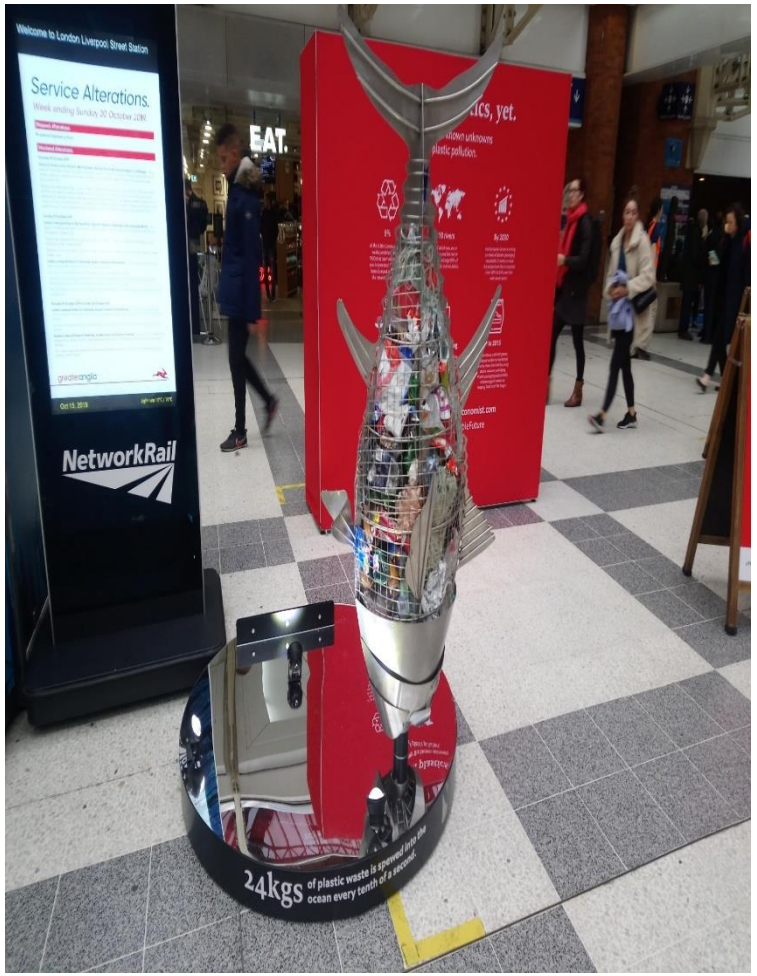

Figure 1 A public awareness campaign; an artwork depicting the extent of the discharge of plastics into the marine environment (Liverpool Street Train Station, London UK, 2019).

Null Hypotheses

- H1: the diversity and distribution of microplastic in the terrestrial and marine environment is quite narrow.
- H2: the threat of microplastics to food safety and supply chain is not significant.
- H3: the consumers have little awareness of the toxicity of microplastics / nanoplastics and their possible adverse health effect on human.

Figure 2
The Covid-19 pandemic disposable plastic PPE (Source: https://science.sciencemag.org/content/369/6509/1314).

Method

- It is a two pronged research; a review supported by a small focus group (n= 72) anonymous online survey using JISC online.
- The questionnaire was designed to assess the consumer awareness and perception of the environment, food safety and supply threats of microplastics and nanoplastics.

Table 1

Examples of drinks, foods and food sources contaminated with microplastics

Drink, Food and Food Source	Location	Reference
Fruits and vegetables	Catania, Italy	Oliveri Conti et al., 2020
Fish (mullet & croaker)	Malaysia	Karami et al., 2017
Milk, beer, honey, soft drinks	Ecuador	Diaz-Basantes et al., 2020
Packaged meat	Not-stated (Europe)	Kedzierski et al., 2020
Soft drinks, energy drinks, cold tea	Mexico City, Mexico	Shruti et al., 2020
Squid & crab	Kerala, India	Daniel et al., 2020
Table salt	Turkey	Gündoğdu, 2018
Water (bottled)	Thailand	Kankanige and Babel, 2020
Water (tap)	China	Tong et al., 2020

Results and Discussion

Main findings 1

Micro- and Nanoplastics and environmental pollution

- The survey data had a low standard deviation and a coefficient of variation less than one (CV <=1)
- Hypothesis (H1) was, rejected microplastics are ubiquitous, everywhere from the Artic region to the Antarctica.
- There is also over whelming evidence for increasing pollution and exacerbation by the massive use of plastics in the PPE production Covid-19 pandemic (Figure .2).

Main findings 2

Micro- and Nanoplastics and the food safety

- The consumer awareness of the food safety implication of micro- and nanoplastics is outstanding, the restricted online survey (n=72) showed that about 87% believed that microplastics are present in their foods.
- 97.2% thought that microplastics are toxic food contaminant and could have a long term health implication (Tables 1 & 2). Thus supporting hypothesis (H3).
- No clear evidence of the direct impact of microplastic on food safety (Rainieri and Barranco, 2019) Hypothesis (H2) was neither proved nor disproved.. EFSA (2016) stated that the occurrence data for microplastics in seafood is limited.
- An unknown threat may be posed by nanoplastic through migration across the cellular membranes and becoming an integral part of the tissue of food sources. Establishing a food safety link is an immense

Main findings 3

Micro- and Nanoplastics and the food supply chain

- Reduced mobility through entanglement and digestive and reproductive impairments, (Bringer et al.., 2020 and Yu et al.., 2018) (Table 1), impacts severely on the populations of the organisms and hence a reduction in supply.
- There is negative cascade effect on the ecosystem and then the food supply chain.
- The keys to a significant reduction of the threats are curbing the industrial appetite for use of plastics, developing reduction strategies and using biodegradable alternatives. Public awareness campaign as depicted in Figure 1 should be encouraged.

Table 2

The survey responses: consumer awareness and perception of the toxicity and health impact of microplastics and nanoplastics.

	A summary of the survey response				
Survey Questions		Responses (%)		Mean Rank	Standard deviation
		Yes	No		
1	Have you ever heard about microplastics?	77.8	22,2	1.22	0.42
2	Have you ever heard about nanoplastics?	56.9	43.1	1.43	0.25
3	Do you think that the food you consume can be contaminated with microplastics	87.5	12.5	1.13	0.33
4	Do you think that microplastics and nanoplastics can be toxic or can carry toxic materials?	97.2	2.8	1.03	0.16
5	Do you think that consuming microplastics could affect your health in the long term?	97.2	2.8	1.03	0.16

Conclusion

- Sufficient evidence for the adverse environmental impact of micro-nanoplastics and subsequent effect on food safety and supply.
- Direct evidence of the impact of microplastics on human health remains mainly speculative.
- The environmental, food safety and supply threats of micro- and nanoplastics has been exacerbated by the urgent and radical measures taken to control the COVID-19 pandemic. An unprecedented amount of plastic PPE were introduced globally into the environment (Ağalar and Engin, 2020; Fadare and Okoffo; 2020; Gordon and Thompson 2020).

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