Microplastics in the Nigerian Environment- A review

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Abstract: The use of plastics and their applications is growing by the second. Their quick production and consequent improper disposal have made plastics a concern for researchers and policymakers. Plastics less than 5 mm are called microplastics and are now found almost everywhere. Microplastics are resistant to microbial degradation and can spend a century before being thoroughly degraded. It has since gotten the attention of researchers, and a lot of research has been done in other countries, but only a handful has been done in Nigeria. Based on this research, it is established that microplastics are ubiquitous in the Nigerian environment; they have been traced to water bodies, soil, and aquatic animals. They are also found to adsorb other known contaminants (e.g., heavy metals, polycyclic aromatic hydrocarbons (PAHs), etc.) on their surface. This paper further suggests possible solutions to allow for proper plastic waste management. The Nigerian scientific community still needs to provide more data on this subject for us to fully understand its impacts on everyday citizen's life

Keywords: Plastic pollution, Microplastic, Microfiber, Green plastics

1. Background

Over the past century, Plastics have progressed from being virtually non-existent to becoming a pervasive and vital element of life in Nigeria. It is inexpensive, long-lasting, and adaptable, making it a critical aspect of the average Nigerian's life. It has proven effective in various industries, including health care, food packaging, and fashion.

However, Plastics are accumulating in the environment, and this problem will remain for centuries due to their low biodegradability. Plastic bag litters have been discovered in every

nook and cranny of the state lately, resulting in significant pollution problems. Plastic and microplastic waste has a harmful influence on the environment, as well as on society and the economy, e.g., causing harm/death to marine organisms and entering the food chain, resulting in health issues

Green and environmentally friendly alternatives to plastics are currently being manufactured from renewable feedstocks and have begun to enter markets. However, Nigeria's journey to sustainable plastic production will not be easy, as the food and beverage industry's giant manufacturing unicorns continue to use non-biodegradable polyethylene terephthalate bottles as packaging material. Polyethylene bags are still used by every Tom, Dick, and Harry of the country. This paper reviews the environmental threat posed by plastics and microplastics and lists contributions from the Nigerian scientific community, current research gaps, and proffers solutions to the problem.

2. Main Text

2.1 Environmental sources of microplastic pollution

Fred-Ahmadu et al., 2020, classified microplastic pollutants into two

1. Primary Source
2. Secondary Source

2.1.1 Primary Sources

If the plastic particles are synthesized with a size less than 5mm, it is classified as a primary source(Fred-Ahmadu et al., 2020).

The principal sources of microplastics in the environment are as follows:

i.   Exfoliating beads, a type of consumable good, can be found in various personal care products like mouthwash, face wash, and body wash. Microspheres, another common

ingredient, can be found in products like shaving foam, sunscreen creams, lipsticks, glitter powder, mascara, printer toner, and other personal care items

ii. Abrasives are materials that are used to grind, polish, or scrub surfaces to remove dirt, grime, or other substances. They are commonly used in shipyard sandblasting, offshore maintenance, and plastic blasting for clothing and car parts

iii. Dust that is generated during industrial operations, such as grinding and polishing processes.

iv. Maritime equipment with plastic coatings.

v. Dust and fibers released from the deterioration of plastic items in homes and offices, such as paints, textiles, toys, furniture, and floor coverings. Textile fibers from washing machines and dryers.

2.1.2 Secondary sources

This is generated from the breaking down of plastic polymers(Fred-Ahmadu et al., 2020).

These are examples of secondary sources:

i. Improper and unregulated disposal of environmental waste can lead to the release of plastic particles in wastewater.

ii. Plastic debris in the marine environment can come from a variety of sources, including poor marine waste management practices, dirt and other debris being thrown overboard, fishing equipment such as trawls and nets being lost at sea, abandoned equipment, and plastics being carelessly discarded directly into the water during recreational activities such as boating.

iii. Improper disposal of sewage.

iv. Plastic shredding caused by animal activity.

Due to these factors, a large amount of plastic waste can be found in the environment, including on land, in the air, and in water.

2.1.3 Microfibers

Microfibers are tiny fibres shed from textiles, and they are less than 5mm in size. They are emerging environmental pollutants; while it is noted that the importation of fairly used textiles from developed worlds into Nigeria is killing the local textile industry, little is pointed out about the dangers posed by these synthetic fibres. According to a study by Browne et al. (2011), 78% of polyester fibers and 22% of acrylic fibers from domestic washing machine discharges were found on 18 different shorelines worldwide. Thus, importation and continuous patronage of used textiles in Nigeria increase the microfiber load in the environment, and proper legislature should be in place to reduce the quantity.

2.2 Microplastics in the Nigerian environment

A few studies have been done to quantify the amount of microplastics in the Nigerian environment. There is a need for monitoring teams to carry out environmental analysis of the ecosystem for adequate documentation and decision making. The country contains approximately 11,000,000 hectares of inland water system, making up about 11.5% of the total Nigerian landmass. The available data only reports for less than 2% of this region (Adeogun et al., 2020)

2.2.1 Water System

More studies have been carried out on surface water compared to other potential sources. According to a study carried out by Enyoh et al., 2020 in South-Eastern Nigeria, they reported microplastics with high abundance in the downstream, ranging from 440 to 1,556 particles/L. In addition, they reported polyethylene terephthalate (PET) of 29%, Polyethylene (PE) of 22%, polyvinyl chloride (PVC) of 16%, polypropylene (PP) of 14%, and others of 6%

(Enyoh et al., 2020). In another study, Abiodun et al., 2019 reported 67% micropellets in the Lagos lagoon; the micropellets was found to be contaminated with Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated biphenyls (PCBs) (Abiodun et al., 2019; Enyoh et al., 2020).

In another study, a high amount (82%) of microplastics were reported in Elechi Creek in Rivers state, Nigeria(Briggs et al., 2019).Oni et al., 2020 also conducted a study on ten sections of OX-Bow Lake Yenagoa, Nigeria, for two different seasons- Dry and Rainy. They found microplastics in high quantities, polyethylene terephthalate and Plasticized polyvinyl chloride were predominate accounting for 72.63% of the microplastics found in the dry season, while polyvinylchloride accounted for 81.5% of microplastics in the rainy season.

2.2.2 Soil

In another study done on samples collected from four Lagos beaches (Lekki, Eleko, Alpha and Oniru). Fragments of polymers such as polystyrene, polypropylene, and polyethylene were identified to be present in the soil (Ilechukwu et al., 2019). Oni et al., 2020 also in their study carried out in Ox-Bow lake in Yenagoa, Bayelsa, Nigeria, reported microplastics in the range of 310 to 2319 particles/kg (Oni et al., 2020; Wirnkora et al., 2019)

2.2.3 Living Organism

Melanoides tuberculata and *Lanistes varicu*s, gastropods recovered in the Osun river, were screened for microplastics. Microplastics shaped fibre was seen in *Melanoides tuberculate*, while polyethylene film and fibre were reported in *Lanistes varicus* (Akindele et al., 2019). Another investigation conducted by Adeogun et al., 2020 , seven fish species sampled in the Eleyele Lake in Ibadan, Nigeria were screen for microplastics, they reported microplastics in the range of 124 μm and 1.53 mm for all the fishes studied. Styrene, acrylonitrile butadiene styrene (ABS), polypropylene (PP), polyester, ethylene butylene styrene and chlorinated

polyethylene was also reported to be present in *Chironomus* spp. Sampled from Ogun River, *Siphlonurus* spp. recovered from river Osun contained Acrylonitrile Butadiene Styrene and polyester, while *L. viridis* from the Osun river contains polypropylene and polyester (Akindele et al., 2020).

2.3 Toxicology

Microplastics, due to their ubiquity and bioavailability, easily bioaccumulate on injection and inhalation. Its bioaccumulation has been identified as being toxic to the ecosystem; microplastics can easily travel through the food chain. At least one study has reported microplastics in all fields, including organisms (Adeogun et al., 2020; Akindele et al., 2020; Fred-Ahmadu et al., 2020; Oni et al., 2020). Microplastics tend to adsorb other environmental pollutants like heavy metal and organic contaminants on their surface. This secondary pollutant has previously been identified to be toxic and cause different ailments. Abiodun et al., 2019 in a study, evaluated the amount of endocrine disruptors such as Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated biphenyls (PCBs); they reported PCBs concentration in the range of 76 to 1043 ng/g while 46.05 to 3984.05ng/g was reported for Polycyclic Aromatic Hydrocarbons (PAHs). This shows that there is more to microplastic toxicity; more studies are required to fully assess the risk.

2.4 Research Gap

Research in other country has evolved beyond the analytical quantification of microplastics in the food chains. Researchers are now working toward assessing the risk associated with microplastic consumption using different methodologies, and they are also modelling the proliferation of microplastics in the food ecosystem. In conjunction with government parastatals, researchers are also studying the correlation between plastic pollution, plastics reduction, and formulating policies to prevent mass poisoning of their entire population.

However, the Nigerian research community is just waking up to the reality of microplastic pollution. The government and researchers should work towards getting more hands in this field to answer some vital question which poses health challenge to its entire populace

1. In the air: How much Microplastics do we have? How much are we inhaling? How much can be found in Human systems?

2. In potable Water: How much microplastics are we drinking? How can we equip our water corporations to remove them from our supply

3. In Living Organism: How much is in plants, how much is in animals and other human consumables

Answers to these questions will help us understand and prevent the mass toxicity of the Nigerian populace.

2.5 Way Forward

2.5.1   Extended Producer Responsibility

Extended producer responsibility (EPR) is a waste management approach that is gaining popularity globally, particularly in developed countries such as the United Kingdom, Canada, Japan, and South Korea. The goal of EPR is to encourage recycling and reduce the amount of plastic waste sent to landfills. (Ogunola et al., 2018). Under this policy, producers of products and packaging, as well as manufacturers and importers, are responsible for managing the end-of-life handling and recycling of plastic waste materials. EPR aims to hold these companies accountable for the plastic and packaging debris that can be found in public spaces. To achieve this goal, EPR requires the provision of accessible litter bins and recycling sites to prevent land-based pollution.

The National Environmental Standards and Regulations Enforcement Agency (NESREA) and the Lagos State Environmental Protection Agency (LASEPA) should monitor and enforce EPR

on a national and state level, respectively. The Food and Beverage Recycling Alliance (FBRA) should also ensure that the country's food and beverage industry complies with the regulations(Enyoh et al., 2021; Ogunola et al., 2018).

2.5.2 Removing/Cleanup

Plastic pollution is a significant problem that can have serious consequences for both public health and the environment. It is therefore crucial that the government and related organizations take steps to ensure that plastic waste is properly removed from public areas. This is especially important for locations such as beaches, which are prone to plastic pollution and can pose health risks to those who come into contact with the contaminated areas.

2.5.3 Behavioural Change strategy

The link between plastic consumption and environmental harm is one that must be recognized and understood by individuals. A recent study conducted in Nigeria sought to assess public perceptions of plastic pollution, and the results showed that a significant portion of respondents, 62.6%, were unaware of this issue. In order to effectively address the problem of indiscriminate release of plastic waste into the environment, it is necessary for both governmental and non-governmental organizations to implement educational outreach and public awareness programs. These efforts can help to change people's attitudes, behaviors, and overall perspective on the issue of plastic pollution. Without a concerted effort to raise awareness and encourage changes in consumption habits, the negative impacts of plastic on the environment will continue to worsen. It is essential that we all take responsibility for our actions and work towards more sustainable and eco-friendly practices (Enyoh et al., 2021; Ogunola et al., 2018)

2.5.4 Provision of Incentives for Responsible Disposal

In order to reduce the amount of plastic pollution in the environment, various countries have implemented collection and recycling programs. For example, some states in the United States, including New York, California, the District of Columbia, Phoenix, and Maine, have

implemented mandatory store take-back programs that allow customers to return single-use plastic bags for recycling at no cost. This type of program could also be implemented in Nigeria to help decrease the amount of indiscriminate waste disposal and decrease the overall presence of plastic in the environment. Implementing such programs is an important step in addressing the issue of plastic pollution and protecting our planet for future generations. (Ogunola et al., 2018)

2.5.5 Biotechnology-bioplastics

Biotechnology offers a new potential approach for managing and eradicating plastic pollution in our environment by producing bioplastics that are environmentally friendly and can be degraded using microorganisms or their components: enzymes, cutinases, lipases, esterases, peroxidases, hydroxylases, hydrolases, and oxidoreductases(Arutchelvi et al., 2008; Zheng et al., 2005). These recently created bioplastics have similar functions and qualities to their traditional plastic equivalents, and they are thought to contribute less to environmental damage. In addition, bioplastics have progressed from their initial simple packaging application to a more complex application in biomedical and technical domains. Bio- and petrochemical-based plastics are made from bio- and crude-oil-derived renewable and non-renewable basic ingredients, starch, vegetable fats and oils, and petroleum have been proven to be entirely or partially biodegradable (Gewert et al., 2015; Ogunola et al., 2018).

2.6 Conclusions

Microplastics have become a major concern as a pollutant that disrupts the balance of the environment, and Nigeria is no exception. While there have been more investigations into microplastics in other countries, there has been relatively little research on this topic in Nigeria. This review illustrates the need for more in-depth studies to fully comprehend the effects of microplastics in Nigeria.

3. List of Abbreviations

Not Applicable

4. Declarations

Ethics approval and consent to participate

Not Applicable

Consent for publication

Not Applicable

Availability of data and material

The author declare that the data supporting the findings of this study are available within the article.

Competing interests

Not Applicable

Funding

No external funding was received.

Authors' contributions

Not Applicable

Acknowledgements

Not Applicable

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