OPEN ACCESS

Kashf Journal of Multidisciplinary Research
Vol: 02 - Issue 07 (2025)
P-ISSN: 3007-1992 E-ISSN: 3007-200X
https://kjmr.com.pk

PLASTICS IN HUMAN FOOD CHAIN AND POTENTIAL HARMS

Nafisa Abdulrahman Ashafa*
Department of Biology, Shehu Shagari College of Education Sokoto, Nigeria.

Article Info

Abstract

The objective of this paper is to make a conceptual review on plastics in human food chain and potential harms Plastics have become a ubiquitous part of modern life, with widespread use in food packaging, production, and consumption. However, the impact of plastics on the food chain is a growing concern. Microplastics, in particular, have been found to contaminate food sources, including seafood, fruits, and vegetables. The consumption of microplastics has been linked to potential health risks, including toxicity and physical harm. This review examines the presence of plastics in the food chain, from production to consumption, and highlights the potential health risks associated with microplastic consumption. Strategies to mitigate the effects of plastics in the food chain are also discussed, including reducing single-use plastics, increasing recycling and reuse, and promoting sustainable food production and packaging. The findings of this review emphasize the need for a comprehensive approach to address the issue of plastics in the food chain. By understanding the impact of plastics on the food chain and taking action to reduce plastic use and waste, we can help protect human health and the environment.

Keywords:

Plastics, food, harm, chemical, microplastic, oxidative stress, consumption.

Introduction

The presence of plastics in the food chain has become a pressing concern in recent years. Plastics are widely used in food packaging, production, and consumption, and their ubiquity has led to a significant amount of plastic waste in the environment. Microplastics, in particular, have been found to contaminate food sources, including seafood, fruits, and vegetables. The consumption of microplastics has been linked to potential health risks, including toxicity and physical harm (Abubakar et al., 2018; Horton & Blissett, 2020).

The food chain is a complex system that involves the production, processing, distribution, and consumption of food. Plastics can enter the food chain at various stages, including during food production, processing, and packaging. Once in the food chain, plastics can be transferred from one trophic level to another, potentially leading to bioaccumulation and biomagnification of toxic substances (Reza & Yousuf, 2016; Shamaki & Shehu, 2017; Soumiya et al., 2018; EPA, 2023; Sarkingobir et al., 2023).

The impact of plastics on the food chain is a multifaceted issue that requires a comprehensive approach to address. It involves understanding the sources and pathways of plastic pollution, the effects of plastics on human health and the environment, and the development of effective strategies to mitigate the problem (Alabi et al., 2019; Ngeno et al., 2022).

This review aims to provide an overview of the presence of plastics in the food chain, the potential health risks associated with microplastic consumption, and the strategies to mitigate the effects of plastics in the food chain. By examining the current state of knowledge on this topic, we can better understand the complexities of the issue and identify potential solutions to address it (Verma et al., 2016; Tait et al., 2020; Takada & Bell, 2021; Sripada et al., 2022). By examining the impact of plastics on the food chain and exploring potential solutions, we can work towards a more sustainable and healthier food system for future generations. The objective of this paper is to make a conceptual review on plastics in human food chain and potential harms.

Importance of food chain in human nutrition

The food chain plays a vital role in human nutrition by providing the necessary nutrients, vitamins, and minerals for human health. Here are some key importance of the food chain in human nutrition:

1. Nutrient Transfer-The food chain transfers nutrients from one trophic level to another, allowing humans to access essential nutrients through the consumption of plants and animals.
2. Food Security-A stable food chain ensures a consistent food supply, which is critical for food security and human nutrition.
3. Diversity of Nutrients-The food chain provides a diverse range of nutrients, including macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins and minerals).
4. Supports Human Health-A well-functioning food chain supports human health by providing the necessary nutrients for growth, development, and maintenance of bodily functions.
5. Influence on Food Quality-The food chain can impact food quality, with factors such as soil quality, water quality, and farming practices influencing the nutritional content of food.

Key Components of a Healthy Food Chain

A healthy food chain involves:

1. Sustainable Agriculture-Sustainable agricultural practices that prioritize soil health, biodiversity, and efficient water use.

2. Responsible Fishing and Hunting-Responsible fishing and hunting practices that ensure the long-term sustainability of fish and animal populations.
3. Safe Food Handling-Safe food handling practices that prevent contamination and ensure the quality of food.
4. Nutrient-Rich Foods-Access to nutrient-rich foods, including fruits, vegetables, whole grains, lean proteins, and healthy fats.

Challenges to the Food Chain

The food chain faces several challenges, including:

1. Climate Change-Climate change can impact food security and nutrition by altering growing conditions, reducing crop yields, and changing the distribution of pests and diseases.
2. Pollution-Pollution can contaminate food sources and impact human health.
3. Overfishing and Overhunting-Overfishing and overhunting can deplete fish and animal populations, impacting food security and nutrition.
4. Food Waste-Food waste can reduce the availability of nutrient-rich foods and contribute to food insecurity.

By understanding the importance of the food chain in human nutrition, we can work towards creating a more sustainable and equitable food system that prioritizes human health and well-being.

Definition of Plastics

Plastics are a group of synthetic or semi-synthetic organic solids that can be molded or shaped into various forms. They are typically made from petrochemicals, which are derived from oil and natural gas. Plastics have several characteristics that make them useful in a wide range of applications:

1. Versatility: Plastics can be formulated to have a wide range of properties, such as flexibility, rigidity, transparency, and durability.
2. Moldability: Plastics can be molded or shaped into various forms, making them suitable for a wide range of applications.
3. Durability: Plastics are resistant to many environmental factors, such as moisture, chemicals, and temperature fluctuations.
4. Lightweight: Plastics are often lighter than other materials, making them suitable for applications where weight is a concern.
5. Cost-effective: Plastics are often less expensive to produce than other materials, making them a popular choice for many applications.

Types of Plastics Resins

There are several types of plastics, each with its own unique characteristics and uses. Here are some common types of plastics:

1. Polyethylene (PE)-Used in plastic bags, containers, and packaging materials.
2. Polypropylene (PP)-Used in packaging materials, automotive parts, and medical devices.
3. Polyvinyl Chloride (PVC)-Used in pipes, vinyl records, and medical equipment.
4. Polyethylene Terephthalate (PET)-Used in water bottles, food packaging, and clothing.
5. Polystyrene (PS)-Used in foam cups, packaging materials, and insulation.
6. Acrylonitrile Butadiene Styrene (ABS)-Used in electronic devices, automotive parts, and medical equipment.

7. Polycarbonate (PC)-Used in eyewear, medical devices, and electronic components.
8. Polyamide (PA)-Used in textiles, automotive parts, and industrial applications.
9. Polyurethane (PU)-Used in foams, coatings, and adhesives.
10. Bioplastics-Made from renewable resources, such as corn starch, sugarcane, or potato starch, and used in packaging materials, disposable cutlery, and bags.

Plastic Identification Codes

Plastic products often have a resin identification code (RIC) that indicates the type of plastic used. The RIC is a number (1-7) surrounded by a triangle. Here's what each number represents:

1. #1 PET (Polyethylene Terephthalate)
2. #2 HDPE (High-Density Polyethylene)
3. #3 PVC (Polyvinyl Chloride)
4. #4 LDPE (Low-Density Polyethylene)
5. #5 PP (Polypropylene)
6. #6 PS (Polystyrene
7. #7 Other (includes polycarbonate and bioplastics)

Understanding the different types of plastics and their uses can help individuals make informed choices about plastic use and disposal.

Types of Plastics

There are many different types of plastics, each with its own unique properties and applications. Some common types of plastics include:

1. Thermoplastics: These plastics can be melted and reformed multiple times without undergoing significant chemical change.
2. Thermosetting plastics: These plastics undergo a chemical change when heated and cannot be melted or reformed.
3. Bioplastics: These plastics are made from renewable resources, such as corn starch or sugarcane, and are biodegradable.

Applications of Plastics

Plastics are used in a wide range of applications, including:

1. Packaging-Plastics are used in packaging materials, such as bottles, bags, and containers.
2. Consumer products-Plastics are used in a wide range of consumer products, such as electronics, toys, and appliances.
3. Medical devices-Plastics are used in medical devices, such as syringes, implantable devices, and diagnostic equipment.
4. Automotive-Plastics are used in automotive parts, such as bumpers, dashboards, and fuel tanks.
5. Construction-Plastics are used in construction materials, such as pipes, vinyl siding, and insulation.

Plastics in human food chain

Plastics have become a concerning contaminant in the human food chain. Microplastics and nanoplastics (MNPs) are ingested through various food sources. Common Food Sources with microplastics include:

- Bottled Water: 93% of bottled water samples analyzed in 9 different countries contained microplastics.

- Seafood: Fish and shellfish can contain microplastics, which are ingested by humans through consumption.
- Fruits and Vegetables: Crops irrigated with contaminated water or grown in soil treated with urban waste-derived fertilizers may contain microplastics.
- Processed Foods: Take-out meals, table salt, rice, beer, and soft drinks have also been found to contain microplastics.

Nevertheless, microplastics can enter the food chain through:

- Direct Ingestion: Marine life ingests microplastics, which are then consumed by humans through seafood.
- Trophic Transfer: Microplastics are transferred from prey to predator, accumulating toxins in the process.
- Habitat Disruption: Plastic pollution alters ecosystems, affecting the food chain and potentially leading to bioaccumulation and biomagnification of toxins (Wagner et al., 2014; UNEP, 2018; Veil & Cook, 2021; Umar et al., 2022).

Harmful effects of plastics in humans

Plastics have become a ubiquitous part of modern life, but their impact on human health is a growing concern. The harmful effects of plastics in humans can be categorized into several areas:

Physical Harm

Microplastic Ingestion-Microplastics can cause physical damage to organs, such as the gastrointestinal tract, leading to symptoms like diarrhea, rectal bleeding, and abdominal cramps.

Inflammation-Microplastics can induce inflammation in the body, potentially leading to chronic diseases like cardiovascular disease, cancer, and autoimmune disorders.

Chemical Toxicity

Endocrine Disruption-Chemicals like BPA and phthalates in plastics can mimic or block hormones, leading to reproductive issues, developmental problems, and metabolic disorders.

Carcinogenic Effects-Some plastics release cancer-causing chemicals, increasing the risk of cancers like breast, colon, and lung cancer.

Neurotoxicity-Exposure to styrene, a chemical found in polystyrene, has been linked to headaches, fatigue, and cognitive impairments

Reproductive and Developmental Issues

Reproductive Problems-Exposure to plastic chemicals has been linked to reduced fertility, birth defects, and pregnancy complications.

Developmental Delays-Children are particularly vulnerable to the toxic effects of plastic chemicals, which can disrupt growth and brain development.

Respiratory Problems

Asthma and Allergies-Inhaled microplastics can trigger respiratory problems, including asthma and lung inflammation.

Lung Damage-Long-term exposure to airborne microplastics may lead to chronic lung diseases.

Other Health Risk

Immune System Suppression-Microplastics can weaken the immune system, making the body more vulnerable to diseases.

Gut Microbiome Disruption-Exposure to microplastics has been linked to changes in the gut microbiome, potentially leading to negative effects on health (Ryan, 2015; Patel et al., 2016; Singh & Raj, 2018;sarkingobir et al., 2020; Sidi & Yahaya, 2022; Umar et al., 2022).

Vulnerable Populations

Some part of the population may be more affected than others. Some of the more affected are as follows:

Children-Children are more susceptible to the harmful effects of plastics due to their developing bodies and brains.

Pregnant Women-Exposure to plastic chemicals during pregnancy can harm fetal development, leading to long-term health problems for the child.

Low-Income Communities-Communities with limited access to healthcare and environmental justice are disproportionately affected by plastic pollution (UNEP, 2018).

Dangerous chemicals in plastics

Dangerous Chemicals in Plastics

Plastics can contain a variety of chemicals that pose health risks to humans and the environment. Some of the most concerning chemicals include:

1. Bisphenol A (BPA)-A chemical used in polycarbonate plastics and epoxy resins, BPA is known to disrupt hormones, particularly estrogen, and has been linked to various health problems, including cancer, reproductive issues, and neurological disorders.
2. Phthalates-Used to make plastics more flexible, phthalates are known endocrine disruptors and have been linked to reproductive problems, birth defects, and developmental issues.
3. Styrene-A chemical used in polystyrene plastics, styrene is a possible human carcinogen and has been linked to respiratory problems, cancer, ad neurological effects.
4. Per- and Polyfluoroalkyl Substances (PFAS)-Used in non-stick coatings and food packaging, PFAS are known to persist in the environment and human body, and have been linked to various health problems, including cancer, reproductive issues, and immune system dysfunction.
5. Brominated Flame Retardants (BFRs)-Used to reduce flammability in plastics, BFRs have been linked to thyroid problems, reproductive issues, and neurological effects (Park et al., 2013; Obebe & Adamu, 2020; Lovo & Rawlings, 2021; Sidi & Yahaya, 2022).

Health Risks Associated with Plastic Chemicals

Exposure to plastic chemicals has been linked to a range of health problems, including:

1. Cancer-Certain plastic chemicals, such as BPA and styrene, have been linked to an increased risk of cancer.
2. Reproductive Problems-Exposure to plastic chemicals, such as phthalates and BPA, has been linked to reproductive issues, including birth defects and infertility.

3. Neurological Effects-Exposure to plastic chemicals, such as styrene and BFRs, has been linked to neurological effects, including cognitive impairment and behavioral problems.
4. Endocrine Disruption-Many plastic chemicals, including BPA and phthalates, are known endocrine disruptors, which can lead to a range of health problems.

Reducing Exposure to Plastic Chemicals is possible by taking major steps. To reduce exposure to plastic chemicals, individuals can take steps such as:

1. Avoiding Plastic Containers-Using glass or stainless steel containers instead of plastic ones.
2. Choosing BPA-Free Products-Opting for products labeled as BPA-free or phthalate-free.
3. Reducing Plastic Use-Minimizing the use of single-use plastics and choosing products with minimal packaging.
4. Avoiding Heating Food in Plastic-Avoiding heating food in plastic containers, as this can cause chemicals to leach into food.

By understanding the risks associated with plastic chemicals and taking steps to reduce exposure, individuals can help protect their health and the environment (Libroin, 2015; Ibrahim et al., 2019; Ibrahim et al., 2021).

How to prevent effects of plastics in food chain?

To prevent the effects of plastics in the food chain, consider these strategies:

Individual Actions

- Reduce single-use plastics-Refuse plastic bags, straws, bottles, utensils, and packaging materials.
- Increase recycling and reuse-Collect used plastic bags or containers and recycle them or reuse jars at home.
- Switch to sustainable alternatives-Use reusable bags, stainless steel water bottles, and biodegradable packaging materials.
- Choose products with minimal packaging-Opt for products with less plastic packaging or those that use biodegradable materials.
- -Support sustainable brands-Buy from brands committed to eco-friendly practices and sustainable packaging.

Food Choices- Reduce intake of highly processed foods*: Highly processed foods often contain a lot of plastic packaging, which can contribute to plastic pollution if not recycled properly.

- Buy imperfect produce-Support farmers who use sustainable methods and purchase "imperfect" produce that may not meet strict cosmetic standards.

Policy and Community-Level Actions

- Implement policies to reduce plastic waste-Governments can introduce policies to reduce single-use plastic consumption and encourage recycling.
- Develop robust recycling infrastructure-Improving recycling systems and technologies can divert plastic waste from landfills and prevent it from entering food chains.
- Promote sustainable food production practices-Encourage organic farming methods, sustainable fishing practices, and reduced use of plastic mulch and irrigation systems in agriculture (Fikri et al., 2017; Bas & Nzewi, 2018; Alabi et al., 2019; Doyan et al., 2024).

Environmental Impact of Plastics

While plastics have many benefits, they also have a significant environmental impact. Some of the environmental concerns associated with plastics include:

1. Plastic pollution-Plastics can pollute oceans and other waterways, harming marine life and ecosystems.
2. Waste management-Plastics can be difficult to recycle and dispose of, leading to waste management challenges.
3. Resource extraction-The production of plastics requires the extraction of fossil fuels, which can have negative environmental impacts.

Overall, plastics are a versatile and widely used material that can have both benefits and drawbacks. By understanding the properties and applications of plastics, individuals can make informed choices about plastic use and disposal (Avio et al., 2016; Abubakar et al., 2018; de Souza et al., 2019).

Uses of plastics in food industry

Plastics are widely used in the food industry for various applications due to their versatility, durability, and cost-effectiveness. Some common uses of plastics in the food industry include:

1. Food Packaging-Plastics are used in packaging materials, such as bottles, containers, and bags, to protect and preserve food products.
2. Food Storage-Plastics are used in food storage containers, such as tubs and trays, to store and transport food products.
3. Food Service-Plastics are used in food service applications, such as disposable cutlery, plates, and cups.
4. Food Processing-Plastics are used in food processing equipment, such as conveyor belts and piping, to facilitate food production.
5. Food Preservation-Plastics are used in food preservation applications, such as vacuum packaging and modified atmosphere packaging, to extend the shelf life of food products (de Souza et al., 2019; Hayes, 2019; Bucci et al., 2020).

Benefits of Plastics in the Food Industry

The use of plastics in the food industry offers several benefits, including:

1. Convenience-Plastics provide a convenient and lightweight packaging solution for food products.
2. Protection-Plastics protect food products from contamination, damage, and spoilage.
3. Cost-effectiveness-Plastics are often less expensive than other packaging materials, making them a cost-effective solution for food manufacturers.
4. Versatility-Plastics can be formulated to have various properties, such as flexibility, rigidity, and transparency, making them suitable for a wide range of food packaging applications.

Challenges and Concerns

While plastics are widely used in the food industry, there are also challenges and concerns associated with their use, including:

1. Food Safety-Plastics can potentially contaminate food products with chemicals, such as BPA and phthalates.

2. Environmental Impact-Plastics can contribute to environmental pollution and waste management challenges.
3. Sustainability-The use of plastics in the food industry can be unsustainable, particularly if plastics are not recycled or disposed of properly (Jambek, 2015; Ademakoya, 2020; Alabi et al., 2019).

Harmful effects of plastics in human food chain

Plastics have become an integral part of modern life, but their impact on the human food chain is alarming. Microplastics, tiny plastic particles less than 5mm in size, have been found to contaminate food sources, including seafood, fruits, and vegetables. The consumption of microplastics has been linked to potential health risks, including:

- Physical Harm-Microplastics can cause physical irritation to the gastrointestinal tract, leading to inflammation and symptoms such as abdominal pain, bloating, and changes in bowel habits.
- Chemical Toxicity-Microplastics can absorb and carry toxic chemicals, such as heavy metals and polycyclic aromatic hydrocarbons, which can lead to adverse health effects.
- Endocrine Disruption-Microplastics can interfere with hormone production, release, transport, metabolism, and elimination, potentially leading to endocrine disorders, including metabolic and developmental issues, and reproductive problems.
- Immune System Dysfunction-Accumulated exposure to microplastics has been linked to chronic inflammation and homeostasis changes, potentially activating the innate immune system.
- Oxidative Stress-Microplastics may cause oxidative stress, leading to inflammation and potentially harming human health.

The presence of microplastics in the food chain is a growing concern, with studies detecting them in various food items, including:

- -Seafood-Microplastics have been found in fish and shellfish, which can accumulate toxic compounds and potentially harm human health.
- Fruits and Vegetables-Microplastics have been detected in fruits and vegetables, particularly those irrigated with contaminated water or grown in soil treated with fertilizers derived from urban waste.
- Bottled Water-Microplastics have been found in bottled water samples, raising concerns about human exposure (Verma et al., 2016; Kaoje et al., 2017; Magami et al., 2017; Prakash, 2017; Rasul et al., 2021; Sabo et al., 2022; Nnebue & Abubakar, 2023; Pathak et al., 2024).

Future Directions

The food industry is exploring new and innovative ways to use plastics, including:

1. Biodegradable Plastics-Biodegradable plastics are being developed to reduce the environmental impact of plastic waste.
2. Sustainable Packaging-Food manufacturers are exploring sustainable packaging solutions, such as compostable packaging and reusable containers.
3. Circular Economy-The food industry is adopting circular economy principles to reduce waste and promote the recycling and reuse of plastics (Patel et al., 2016; Velis & Cook, 2021).

Conclusion

In conclusion, plastics are a ubiquitous part of modern life, with a wide range of applications and benefits. However, the environmental impact of plastics, particularly in the food chain, is a growing concern. The use of plastics in food packaging and production can lead to plastic pollution, which can harm marine life

and ecosystems. To mitigate the effects of plastics in the food chain, it is essential to adopt sustainable practices, such as reducing single-use plastics, increasing recycling and reuse, and promoting sustainable food production and packaging. Individuals, governments, and industries must work together to address the plastic pollution problem and ensure a healthier and more sustainable food system for future generations. By understanding the impact of plastics on the food chain and taking action to reduce plastic use and waste, we can help protect the environment, conserve natural resources, and promote a healthier and more sustainable food system.

REFERENCES

Abubakar, A., Barnabas, M.H., & Tanko, B.M. (2018). The physico-chemical composition and energy recovery potentials of municipal solid waste generated in Numan Town, North-Eastern Nigeria. Energy and Power Engineering, 10, 475-485.

Adekomaya, O. (2020). Contributing to climate change on sustainability of biodegradable material-adaptation of alternative measures. NIPES Journal of Science and Technology Research, 2(2), 102-107.

Alabi, O.A., Ologbunjaye, K.I., Awosolu, O., & Alalade, O.E. (2019). Public and Environmental health effects of plastic wastes disposal: A review. Journal of Toxicology and Risk Assessment, 5(2), 1-13.

Avio, C.G., Gorbs, S. and Regolif (2016). Plastics and microplastics in the oceans from emerging pollution to emerged threat. Marine Environmental Research, xxx: 1-10.

Bas, O.N. & Nzewi, N.U.(2018). Plastic water bottles, sand and hydroform blocks, building materials for the urban poor housing: A new phenomenon. Journal of Environmental Management and Safety, 9(1),1-35.

Bucci, K., Tulip, M, & Rochman, C.M.(2020). What is known and unknown about the effects of plastic pollution: A meta-analysis and systematic review. Ecological Application, 30(2), 1-17.

de Souza Machado, A. A.; Lau, C W.; Kloas, W.; Bergmann, J.; Bacheier, J. B.; Fatin, E.; Becker, R., Goerlich, A. S., and Rillig, M. C. (2019). Microplastics can change so properties and affect plant performance Environmental Science and Technology.2019, 53, pp6044-6052. https://pubs.acs.org/doi/10.1021/acs.est.9b01339

Doyan, A., Prayogi, S., Méité, N., Sarkingobir, Y.,Kouamé, A.N., &Yaya, O. L. (2024). Optical Properties of Polyvinyl Alcoho-Based Polymer Films Containing Methylene Blue and Trichoroacetic Acid for Gamma Radiation Dosimetry Appications. Lensa: Jurnal Kependidikan Fisika, 12(1), 98-115. doi:https://dx.doi.org/10.33394/j-kf.v12i1.11908

Fikri, E., Purwanto, P. & Abdurachimi, H.R. (2017). Characteristics and household toxic hazardous waste generation based on economic status and topographic regions in Semarang City, Indonesia. Journal of Ecological Engineering, 18(5), 8-16.

GESAMP (2015). "Sources, fate and effects of macroplastics in the marine environment: a global assessment" (Kershaw, P. J., ed.). (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 90, 96 p.

Hayes, D. (2019). Micro and nanoplastics in soil: should we be concerned. Report No.PA-20k-01. United States Department of Agriculture.

Horton, A.A. & Blissett, I. (2020). Impacts of plastic pollution on freshwater aquatic, terrestrial, and avian migratory species in the Asia and Pacific region.https://www.cms.int.

Ibrahim, M., Barau, L., Alhassan, M., Gidadawa, Z.S., & Dan Galadima, H. (2019). Assessment of environmental impact of solid waste generation and disposal in Sokoto metropolis. International Journal of Scientific and Research Publications, 9(5), 377-383.http://dx.doi.org/10.29322/IJSRP.9.05.2019.p.8945.

Ibrahim, M.F., Hod, R., Toha, H.R., Nawi, M.A., Idris, I.B., Yusoff, M., & Sahani, M. (2021). The impacts of illegal toxic waste dumping on childrens health: A review and case study from Pasir Gudang, Malaysia. International Journal of Environmental Research in Public Health, 18(221), 1-18. Http://doi.org/10.3390/ijerph18052221.

Jambeck, J.R., Geyer, R., Wilcox, C., Sisegler, T.R., Perryman, M., Andrady, A., Narayan, R., & Law, K.L. (2015). Plastic waste inputs from land into the ocean. Marine Pollution, 347(6223),768-771.

Kajoe, A.U., Sabir, A.A., Yusuf, S., Jimoh, A.O., & Raji, M.O. (2017). Residents perception of solid waste disposal practices in Sokoto, Northwest Nigeria. African Journal of Environmental Science and Technology, 11(2), 94-102. http://doi.10.5897/AJEST2014.1791.

Libroin, M. (2015). Redefining pollution and action: The matter of plastics. Journal of Material Culture, DOI:10.177/1359/835/5622966.

Lovo, S. & Rawlings, S. (2021). Garbage in, garbage out: the impact of e-waste dumping sites on early child health. Department of economics, Discussion paper No.2021-07. www.readings.ac.uk.

Magami, I.M., Maishanu, H. M., & Danbare, B.M. (2017). Survey of waste disposal and its perception among residents of Sokoto Metropolis, north-Western Nigeria. International Journal of Pure and Applied Biosciences, 5(2), 9-13. http://dx.doi.org/10.18782/2320-7051.2456.

Mbue, I. N., Bitondo, D., & Azibo, B.R. (2015). Municipal solid waste generation, composition, and management in the Douala municipality, Cameroon. Journal of Environment and Waste Management, 2(4), 91-101.

Ngeno, E.C., Mbuci, K.E., Necibi, M.C., Shikuku, V.O., Olisah, C., Ongulu, R., Matovu, H., Ssebugere, P., Abushaban, A., & Sillanpaa, M. (2022). Sustainable re-utilization of waste materials as adsorbents for water and wastewater treatment in Africa: Recent studies, research gaps, and way forward for emerging economies. Environmental Advances, 9(100282),1-14.

Nnebue, W.M. & Abubakar, S.A. (2023). Urban planning perspectives -Evolving solution to plastic pollution in Nigeria. Ilaro Journal of Humanities and Management,3,20-29.

Obebe, S.B. & Adamu, A.A.(2020). Plastic pollution: Causes, effects and preventions. International Journal of Engineering, Applied Science and Technology,4(12),85-95.

Park, Y.K., Kim, W. & Jo, Y.M. (2013). Release of harmful air pollutants from open burning of domestic municipal solid wastes in a metropolitan area of Korea. Aerosol and Air Quality Research,13,1365-1372.

Patel, P.A., Shah, A., & Patel, H.(2016). Waste plastic bottle materials with sustainable application. International Journal of Innovative and Emerging Research in Engineering, 3(3),38-45.

Pathak, G., Nichter, M., Hardon, A. & Moyer, E. (2024). The Open Burning of Plastic Wastes is an Urgent Global Health Issue. Annals of Global Health, 90(1), 3, 15. DOIhttps://doi.org/10.5334/aogh.4232

Prakash, S.(2017). Impact of plastic pollution on environment and human health: An overview. Iconic Research and Engineering Journals, 1(5), 53-59.

Rasul, T., Islam, M., Sajjad, S.I., Islam, Z. (2021). Impact of wastewater discharge to the River Turag: A case study adjacent to the IUBAT. IUBAT Review, 4(1),48-54.

Reza, A., & Yousuf, T.B. (2016). Impacts of waste dumping on water quality in the Burigangan River, Bangladesh and possible mitigation measures. Journal of the Environment, 11(1), 35-40.

Ryan, P.G. (2015). A Brief History of Marine Litter Research. In: M. Bergmann, L. Gutow and M. Klages (eds.) Marine Anthropogenic Litter. Cham: Springer

Sabo, G., Zayyanu, A., Abdullahi, K.M., Malami, Z., Aliyu, A., Muhammad, S., Bello, A. (2022). Assessment of biomedical waste management among primary healthcare workers in Gwadabawa local government of Sokoto state, Nigeria," Transaction on Biomedical Engineering Applications and Healthcare, 2 (1)1-9.

Sarkingobir, Y., Bello, A M. Yabo, H.M. (2021). Harmful effects of plastics on air quality. Academia Letters, Article 2967. Https://doi.org/10.20935/AL2967.

Sarkingobir, Y., Umar, A. I., Miya, Y.Y., Hamza, A., Tambari, U., Sule, I.F., & Magori, D.Z. (2022). Determination of Selected Essential (Copper, Zinc) And Non-Essential (Lead, Chromium, Cadmium) Heavy Metals in Some Single-Use Plastics from Sokoto Metropolis, Nigeria

Sarkingobir, Y., Umar, A.I., & Shagari, K.A. (2020). Nanoplastics: Small science with bigger consequence. Proceedings of Virtual International Conference on Advancements in Nanotechnology (VICAN) & association of Indian Biologists (AIB).

Sarkingobir, Y., Waheed, S.A., Abubakar, M., & Gilani, N. (2023). Plastic waste materials in a classroom environment: An assessment of nursery classes in Sokoto state, Nigeria. Pakistan Journal of Social Science, 43(2), 217-226.

Shamaki, S.B. & Shehu, A.A. (2017). Assessment of solid waste management in Sokoto metropolis. Journal of Agriculture and Environment, 13(2), 159-167.

Sidi, A.S., & Yahaya, U.F. (2022). Chemical additives of concern in electronic plastics: Theoretical view. ISSRA Journal of Applied Medical Sciences, 1(3), 12-19.

Singh, A., & Raj, P. (2018). Segregation of waste at source reduces environmental hazards of municipal solid waste in Patna, India. Archives of Environmental Protection, 44 (4), 96-110.

Singh, J., Saxena, R., Bharti, V., & Singh, A. (2018). The importance of waste management to environmental sanitation: A review. Advances in Bioresearch, 9(2), 202-207.

Soumiya, M., Balakrishnan, & Shanthi, K. (2018). Composition of municipal solid waste accumulated in Vellalore dump yard from Coimbatore City. Research Journal of life Sciences, Bioinformatics, Pharmaceutical and Chemical sciences, 4(40, 156-164.

Sripada, K., Wierzbicka, A., Abass, K., Grimalt, J.O., Erbe, A., Rollin, H.B., Weihe, P. etal (2022). A children's health perspective on nano-and microplastics. Environmental Health Perspectives, 130(1), 1-15.

Tait, P.W., Brew, J., Che, A., Costanzo, A., Danyluk, A., Davis, M., Khalaf, A., McMahon, K., Watson, A., Rowcliff, K., & Bowles, D. (2020). The health impacts of waste incineration: A systematic review. Australian and New Zealand Journal of Public Health, 44 (1), 40-8.

Takada, H. & Bell, L.(2021). Plastic Waste Management Hazards. International Pollutants Elimination Network (IPEN), June 2021.

Umar, A.I., Sarkingobir, Y., and Dikko, M., (2022). Spectro-analytical research of selected heavy metals (Cu, Cd, Cr, and Pb) in four different single-use plastics commonly in contact with food from Sokoto, Nigeria. Jurnal Teknokes,15(1):76-80. https://doi.org/10.35882/tekenokes.v15i2.199.

UNEP (2018). SINGLE-USE PLASTICS: A Roadmap for Sustainability (Rev. ed., pp. vi; 6).

United States Environmental Protection Agency (2023). Best practices for solid waste management: A guide for decision makers in developing countries.

Velis, CA & Cook, E. (2021) Mismanagement of Plastic Waste through Open Burning with Emphasis on the Global South: A Systematic Review of Risks to Occupational and Public Health. Environmental Science and Technology, 55 (11). pp. 7186-7207. ISSN 0013-936X

Verma, R., Vinoda, K.S., Papireddy, M., & Gowda, A.N.S. (2016). Toxic pollutants from solid waste- A review. International Conference on Solid Waste,1conSWM,35(2016), 701-708.

Wagner, M., Scherer, C., Alvarez-Munoz, D., Brennholt, N., Bourrain, X., Buchinger, S., Fries, E., Grosbois, C., Klasmeier, J., etal (2014). Microplastics in freshwater ecosystems: what we know and what we need to know. Environmental Sciences Europe, 26(12),1-9.