NANGARHAR UNIVERSITY
INTERNATIONAL JOURNAL OF BIOSCIENCES
ORIGINAL ARTICLE
e-ISSN: 2957-9988
NUIJB Vol 3, Issue 1 | 2024

Received: 23 Dec 2023 Accepted After Revision: 22 Jan 2024 Published Online: 10 Feb 2024

Plastic Pollution Unveiled: Causes, Impacts, and Effective Prevention Methods

Shinwari Saifullah [1*], Mukhlis Sifatullah[1], Elmi Fazalkarim[1], Mirzakhil Attullah[1], Kochai Khdaidad [1], Sharafmal Din mohammad [1], and Ihsan Ihsanullah[2]

[1*] Department of Chemistry, Faculty of Education, Nangarhar University, Nangarhar, Afghanistan

[2] Department of Geography, Faculty of Education, Nangarhar University, Nangarhar, Afghanistan

*Corresponding author email: saifullahshinwari999@gmail.com

ABSTRACT

Environmental pollution is considered a global issue nowadays and immense efforts are being made to prevent it. Plastic pollution has become one of the most pressing environmental issues as plastics are accumulating worldwide on land and in oceans due to rapid population growth and urbanization. The amount of plastic garbage created has grown due to the fast population development, creating significant problems for its disposal. Plastic products are made up of various elements such as carbon, hydrogen, oxygen, nitrogen, chlorine, and sulfur. Plastics and natural materials such as rubber or cellulose are composed of very large molecules, or polymers, through a process called polymerization. Plastics are produced under specific and appropriate temperature and pressure conditions, additional plastics from industrial and municipal sources have caused headaches for agencies tasked with handling them. There are various methods for processing these materials. Various common methods to prevent plastic pollution have been investigated through this literature research. The result of the research revealed that there are two common ways to prevent the pollution of plastic products, one of which is to bury them and burn them, and the second way is the process of recycling, which can be used as a secondary product, gas, or oil. It can serve as an energy source.

Keywords: Plastic pollution, plastic additives, plastic recycling, engergy

INTRODUCTION

The proliferation of plastic sources has been driven by economic development and the associated costs of evolving products. Concurrently, the rapid growth of cities and international economic advancements have contributed to a notable increase in plastic production. Over the past six decades, global plastic production has surged from 5 million tons to an astonishing 100 million tons. This growth can be attributed to the international development of plastic resources and the corresponding rise in demand, fueled by the increased availability of plastic materials (Guatum, 2009). More than 400 million tons plastics are produced per year in all over the world, and most of them are used in water bottels which makes 36% of all plastic products, and 16% are used in the building and construction as shown in figure 1. The substantial production of plastic has resulted in the generation of solid plastic waste, ranking as the third largest waste stream after food, paper, and cardboard waste. The expanding cities and growing population have led to the extensive use of plastics on a large scale for packaging, covering, and shipping purposes. Consequently, the accumulation of plastic waste presents significant challenges for municipalities and environmental protection agencies. These plastic residues persist underground for hundreds of years without decomposing, posing numerous environmental issues in addition to their sheer volume (Colin, 2006). The implementation of recycling initiatives for these surplus plastic items offers a valuable solution to curb waste generation and mitigate environmental pollution. Research conducted in this field demonstrates that recycling processes are cost-effective compared to initial manufacturing and are considered economically successful, resulting in the production of high-demand goods. Many countries have undertaken such projects to address this issue, and the United Nations Environmental Protection Agency (UNEP) has launched the 3R program (Reduce, Reuse, and Recycle) to tackle plastic pollution comprehensively. This program encompasses source separation, collection, and transportation of plastic waste, as well as the production of material and energy resources, considering the overall cost implications. In recognition of the urgency, the United Nations designated 2018 as a dedicated year to combat plastic pollution (Tibbets, 2015). The 3R program encompasses three primary objectives. Firstly, it aims to reduce the

consumption of these items, advocating for their limited use. Secondly, it promotes the reuse of plastic items in their existing form for alternative purposes. Lastly, it emphasizes the recycling of plastic waste to produce new items, involving the collection and processing of discarded materials (Governmental Report, 2010). Plastic production surged after World War II, reaching 381 million tons by 2015. Despite their lightweight, durable, and cost-effective nature, plastics pose environmental hazards due to their non-biodegradable nature. The COVID-19 pandemic has exacerbated plastic waste and pollution. In 2020, Europe saw an increase in plastic production, leading to increased plastic waste and pollution. Addressing these environmental challenges requires exploring alternative materials and addressing the non-biodegradable nature of plastics.

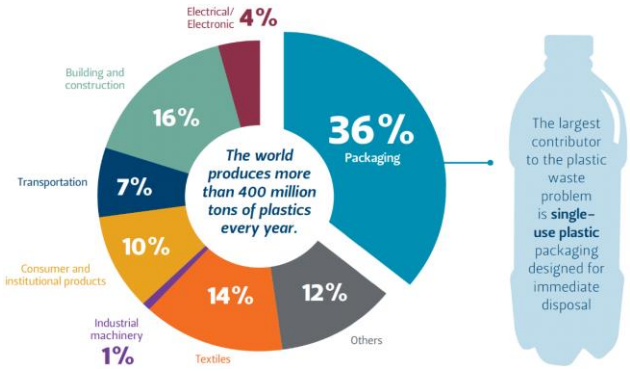

Figure 1. Global Plastic Production by Industrial Sector

INTRODUCTION TO PLASTIC PRODUCTS

Plastics are organic materials produced through polymerization processes, characterized by their typically high molecular weight. In general, plastics can be categorized into two main types: Thermoplastics: This type of plastic exhibits a soft and malleable nature. When subjected to elevated temperatures, thermoplastics can be shaped and molded. Upon cooling, they solidify and retain their new form. Notably, thermoplastics can be recycled and used to create other plastic products. Examples of thermoplastics include polyethylene, polyester, and polyvinyl chloride. Thermosetting Plastic: Unlike thermoplastics, thermosetting plastics undergo a permanent change in shape once they are molded and solidified. They are not suitable for heating and reshaping, as they maintain their solid and rigid structure. Examples of thermosetting plastics include phenol formaldehyde and urea aldehyde.

IMPACTS OF PLASTIC POLLUTION

In 2015, a staggering 6,300 metric tons of plastic waste was generated, with only 9% being recycled, 12% incinerated, and a significant 79% ending up in landfills. The incineration of plastic waste releases highly toxic gases, including hydrogen chloride, hydrocyanic acid, carbon monoxide, carbon dioxide, sulfur dioxide, as well as organic compounds such as toluene, xylene, phenol, benzol, benzaldehyde, heavy metals, and polycyclic aromatic hydrocarbons (Governmental report, 2010). Given that plastic is derived from petroleum derivatives, it is non-biodegradable. The accumulation of additional plastic materials in the environment leads to air, soil, and water pollution, resulting in the proliferation of various diseases among humans. Recent research has highlighted the physical harm and chemical toxicity caused by plastics to humans (Obebe & Adamu, 2020). Furthermore, studies conducted on marine environments in 2019 have revealed that plastic materials enter the digestive systems of marine animals, including fish, causing significant harm to their well-being (Tibbetts, 2015).

Current Approaches to Prevent Plastic Pollution

International strategies are being used to combat plastic pollution, ranging from simple methods like soil burying to advanced techniques using temperature-controlled devices. To prevent plastic pollution, alternative materials, recycling, sustainable waste management, a circular economy, reusable items, innovative technologies, public awareness, and international cooperation are being promoted. These methods aim to soften and repurpose plastic, promoting a circular economy and reducing environmental impacts.

Burial in the Ground Method

Plastic waste management involves storing and burying materials underground, but this method has challenges such as requiring large land areas and requiring chemicals and energy resources. In 2008, 29.2 million tons of plastic were buried in the United States. Haphazard burying can lead to wind dispersal, contaminating streams, rivers, and oceans. Buried plastic can release pollutants like phthalates and bisphenols into the environment during decomposition. Bisphenol is primarily used in polycarbonate plastics and is found in shatterproof windows, eyewear, water bottles, and water supply pipes. Phthalates are plasticizers that enhance plastic durability and are found in vinyl flooring, lubricating oils, and personal care items. Both methods have their pros and cons (Trividi & Singh, 2021).

Incineration Method

Incineration is a popular method for reducing solid waste, offering space efficiency and energy generation. However, it can release toxic gases, including heavy metals and organic pollutants, which can cause environmental contamination. These pollutants, such as lead, zinc, arsenic, and mercury, can disperse into the atmosphere as particulate matter and smoke. These pollutants pose significant environmental and health risks. To mitigate these effects, recycling is an alternative approach. By diverting plastic waste from incineration and implementing recycling practices, harmful emissions and associated environmental and health impacts can be significantly reduced (Gnatowski, 2022).

Recycling Method

Plastic recycling is a process aimed at reducing natural resource depletion and environmental damage by reducing the influx of new materials. Four procedures are proposed to prevent plastic pollution: mechanical recycling, chemical and thermal conversion, down cycling, and energy recovery. Mechanical recycling involves heating and drying plastic materials, followed by thorough washing. Chemical and thermal conversion converts plastic into monomeric components for polymeric products, while down cycling converts plastic into low-value materials for alternative goods. Energy recovery burns plastic waste to generate energy, but concerns about environmental impact persist. Thermoplastics, including polyethylene, polypropylene, and polystyrene, can be used as raw materials for liquid hydrocarbon production (Derraik and Jose, 2002).

Technique for Liquid Oil Production

Plastic waste is a valuable resource for liquid oil production due to its high slag temperature and lower moisture content. The conversion of plastic waste into liquid oil products depends on specific types and methods of plastic, as well as local economic, environmental, social, and technical conditions. Non-harmful materials are used in the conversion process, and each method requires specific materials best suited for the process. The success of this process depends on the specific conditions in each region (Mustafa, 2012).

Production of Combustible Gas

Combustible gas production involves the thermal transformation of organic materials in the presence of oxidants to produce a high-hydrogen-content gas. The gas's quality and quantity depend on polymer composition and thermal conditions. Plastic analysis at 800°C decomposes large molecules like olefins and paraffin’s, generating CO, CH4, and H2 gases (Obebe & Adamu, 2020).

MATERIALS AND METHODS

This research uses a content analysis and descriptive approach to explore strategies for preventing plastic pollution. It begins by searching for relevant scientific sources, including foreign books and articles. The findings are synthesized into a research article, which includes visual aids like pictures and tables to enhance comprehension and provide more information.

RESULTS

Plastic waste in urban areas poses a significant environmental pollution challenge due to its non-biodegradable nature. Disposal methods like burial or incineration are ineffective due to their persistence. Solutions include reusing plastic waste and transforming it into various products through mechanical, thermal, and chemical processes. These processes convert plastic waste into valuable resources like burning oil and gas, making it feasible to obtain fuel from these materials. Low-cost consumables for these processes further enhance their

viability. Implementing these measures not only mitigates environmental pollution but also contributes to industrial development.

DISCUSSION

Obebe and Adamu's research shows that plastic materials remain non-degradable over a thousand years, contributing to environmental pollution. Chemical transformations and thermal transformations are essential for facilitating reuse, with mechanical modifications being the most straightforward approach. Trivedi and Singh's research emphasizes the need for government and national efforts to prevent plastic product pollution, with special attention to education and manufacturing plants producing biodegradable materials. Afghanistan faces significant challenges due to its large plastic waste production. Gnatowski and Kleczkowska's research highlights plastic recycling as the primary mechanical transformation method, identifying additional materials' composition, cleaning and drying, and crushing to produce high-quality products. These findings contribute to the ongoing academic discourse on plastic waste management and environmental sustainability.

CONCLUSION

In conclusion, plastic pollution is a pressing global issue that requires immediate attention. Efforts to prevent plastic pollution include recycling, burying, and burning plastic waste. These methods aim to reduce the environmental impact of plastic and promote a circular economy.

REFERENCES

Colin, B. (2006). Chemistry in your life. New York. WH Freeman and Company. P 190-193

Derraik, J. G. and Jose, B. (2002). The pollution of the marine environment by plastic debris: a review. Marine pollution bulletin, 44(9): 842-852.

Detloff, K.C. (2012). Strategies for solving the plastic pollution problem. Berlin. Germany: The Nature and Biodiversity Conservation Union.p 15 -17

Goodship , V. (2007).Plastic recycling. Science progress. 90(4): 245-268.

Governmental report (2010). National 3R Strategy for Waste Management .Ministry of Environment and Forests Department of Environment ..Government of the People's Republic of Bangladesh .Dhaka

Guatam, S.P. (2009). Assessment of Plastic Waste and Its Management at Airports and Railway Stations in Delhi. Abbrev. CPCB, Delhi., India.p 1 , 8 -9 ,63

Kijo-Kleczkowska, A. and Gnatowski, A. (2022). Recycling of plastic waste with particular emphasis on thermal methods. Energies, 15(6), 2114.p 4-21

Mustafa, A. (2012). Introductory to Polymer Science and Technology. Ireland: Ulster University Publications. P 54-56

Obebe, S.B. and Adamu, A.A. (2020). Plastic pollution: causes, effects and preventions. International Journal of Engineering Applied Sciences and technology. 4(12): 85-95

Tibbetts, J. H. (2015). Managing marine plastic pollution: policy initiatives to address wayward waste. Environ Health Perspect. 123(4): p 90–93

Trivedi, L and Singh, P. (2021). Plastic waste management.gis science journal. volume 7(2):25-31

UNEP REPRT. (2016) . Sound management of chemicals and waste. UNEP/EA.2/Res.7

Zumdahl, S.S. and Zumdahl, S.A. (2009). Chemistry: Media Enhanced Edition. Boston. USA: Houghton Mifflin Company.p 1024-1026