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Graphene-based nanomaterials as potential candidates for environmental mitigation of pesticides

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ABSTRACT

Over the years, bioaccumulation of hazardous chemicals in the food chain has become a critical issue, resulting in numerous health risks. Environmental mitigation aims to clean up contaminated sites and eliminate hazardous materials from the air, water, or soil to restore the site to its original and safe condition. Pesticides constitute one of the most dangerous environmental pollutants which are generally used to increase crop production. Addressing the removal or treatment of pesticides has become pivotal in mitigating environmental threats. Diverse remediation methods are employed to protect the environment and public health. Graphene-based materials have emerged as promising candidates with exceptional properties, including excellent adsorption capacity due to their high surface area, strong hydrophilicity, and tunable properties. Owing to these properties, they have been attracting major research attention in the field of design and fabrication of materials for the mitigation of pesticides from the environment such as from contaminated food, water and other samples. Various physical, chemical and biological extraction techniques are adopted to remove pesticides. This review article provides an insight into the potential role of graphene-based materials in the environmental remediation of pesticides. We have focused on the removal of Organophosphates, Organochlorines, Carbamates and Pyrethroids present in water, fruit, vegetable and other samples, highlighting the urgent need for environmental remediation. While graphene-based materials hold potential for pesticide remediation, addressing challenges in scalable production, assessing long-term sustainability, and mitigating potential environmental impacts are critical steps for successful large-scale applications.

1. Introduction

As industrialization and human activities continue to grow, hazardous substances are being released into landfills, industries, and private properties, posing threats to the environment and human health. This has become a global concern, and new technologies are being explored to combat contamination in air, water, and soil. Environmental remediation refers to the process of the removal or treatment of pollutants or hazardous materials from soil, water and air or cleaning up contaminated environmental sites and restoring them to their original or acceptable state [1].

environment by removing harmful pollutants from various sources, such as soil and water, to protect public health and the environment. These hazardous pollutants include insecticides, herbicides, heavy metals, oil spills, poisonous gases, industrial effluents, sewage, and organic compounds. However, pollutant capture and degradation can be difficult due to the complex mixture of compounds and low reactivity. Therefore, there is a need for ecologically friendly and sustainable materials and approaches in environmental remediation. Environmental remediation can be performed at various scales, from small contaminated sites to large-scale industrial sites, and it often requires the involvement of multidisciplinary teams of experts [2].