


Chapter 6


Functionalized Gold Nanoparticles Enable Colorimetric Biosensing of Pesticides for Advanced Applications: Detection of Pesticides Using Functionalized Gold Nanoparticles

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ABSTRACT

The growing use of pesticides in agriculture poses significant risks to food safety and environmental health. Traditional detection methods are accurate but require

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complex instruments and skilled personnel. Biosensing approaches using functionalized gold nanoparticles (AuNPs) have emerged as rapid, cost-effective, and portable alternatives. This mini-review explores the synthesis, surface modification, and characterization of AuNPs, emphasizing their surface plasmon resonance (SPR) properties for colorimetric biosensing. Pesticide exposure induces aggregation of ligand-functionalized AuNPs, leading to visible color changes detectable without advanced equipment. Recent studies demonstrate the successful detection of pesticides such as paraquat, glyphosate, and deltamethrin across diverse matrices. These biosensors offer advantages like visual output, simplicity, and fast response. Despite some limitations, functionalized AuNPs show strong potential for developing efficient biosensing systems, supporting safer agriculture and environmental monitoring.

INTRODUCTION

Growing population on the earth today is on its peak and world has witnessed the serious issues in last few years like COVID-19, climate crisis, economic troubles, and war etc., which influence the world as a whole. Among the various kinds of challenges, environmental crisis severely impacted the mankind. The greatest concerns for the future are the contaminated and unhygienic air, water, and food. About 50% of the world population depends on different agriculture products and above all the existing population growth trend on globe will increased by 10 billion by 2050 that rises the risk of food security, (Alavi & Rai, 2019). Population demands large amount of foodstuff, to encounter the worldwide demand of food the effective and sustainable strategies has to be implemented for high agricultural yield, (Amaraneni, 2018). To gain more annual yield of agricultural commodities, the pest and insect can be controlled efficiently by use of pesticides because global food supply affected by pests and insects, (Arshad, Hassan, & Naikoo, 2023). Pesticide-free fruits, vegetables, and crops are either a thing of a bygone era that mankind values greatly or are simply illusions of the present. These farming chemicals are adsorbed and absorbed by the surfaces of fruits, vegetables, leaves, and other parts of crops that causes them to disseminate across the ecosystem by entering through bio-chains. The majority of such insecticides and pesticides displays a strong link with human-health and the environment; some are even prohibited because of their potentially hazardous nature, (Bala, Sharma, & Wangoo, 2018; Beyene et al., 2017). Consuming these substances in whatsoever proportion via any of the route causes one's health at risk for conditions including gastrointestinal, dermatological, lung problems, cancer, neurological, and endocrine disruptions, among others and high exposure can even be fatal, (Bhagyaraj, Oluwfemi, & Kalarikkal, 2018; Bhatt, Vyas, & Modi, 2014). In order to mitigate this possible threat, the agro-chemicals

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