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Adsorption of Organophosphate Pesticide Dimethoate on Gold Nanospheres and Nanorods

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Abstract

The contamination of water bodies by organophosphate pesticides poses a significant threat to the environment and human health. The development of effective adsorbents for the removal of these pesticides is of paramount importance. In this study, we investigate the adsorption behavior of the organophosphate pesticide dimethoate on gold nanospheres and nanorods. The aim is to understand the potential of gold nanoparticles as efficient adsorbents for the removal of dimethoate from aqueous solutions.

Gold nanospheres and nanorods were synthesized using a seed-mediated growth method, characterized by transmission electron microscopy, and their surface properties were assessed using zeta potential measurements. The adsorption experiments were conducted by adding known concentrations of dimethoate to the gold nanomaterial suspensions and monitoring the adsorption process over time. The residual dimethoate concentrations were measured using high-performance liquid chromatography analysis.

The results indicated that both gold nanospheres and nanorods exhibited high affinity for dimethoate adsorption. The adsorption process followed pseudo-second-order kinetics, suggesting chemisorption as the dominant mechanism. The equilibrium data fitted well to the Langmuir isotherm model, indicating monolayer adsorption behavior. The maximum adsorption capacities of dimethoate onto gold nanospheres and nanorods were determined to be XX mg/g and XX mg/g, respectively.

The pH of the solution significantly influenced the adsorption process, with higher adsorption observed at lower pH values. Additionally, the presence of coexisting ions, such as chloride and nitrate, showed a slight influence on the adsorption efficiency of dimethoate.

The findings of this study highlight the potential of gold nanomaterials, specifically nanospheres and nanorods, for the removal of organophosphate pesticides from contaminated water systems. The high adsorption capacities and pH-dependent behavior of gold nanomaterials suggest their applicability in various environmental conditions. Further research is needed to explore the feasibility of scale-up processes and the long-term stability of gold nanomaterials for practical environmental applications.

Keywords: Gold nanospheres; Gold nanorods; Dimethoate; Adsorption; Organophosphate pesticide; Environmental remediation

Introduction

Organophosphate pesticides are widely used in agricultural practices to control pests and increase crop yields. However, their extensive use has led to serious environmental concerns due to their persistence, toxicity, and potential bioaccumulation. Among these pesticides, dimethoate has been identified as a hazardous compound with adverse effects on aquatic ecosystems and human health. Therefore, developing effective strategies to remove dimethoate from contaminated water sources is crucial.

The change in dielectric constant of silver upon pesticide binding which is less compared to that of gold gives the gold advantage over silver or some cheaper metal nanomaterials. Nair and Pradeep supported gold nanoparticles on alumina and made online water filter to demonstrate technology of OPs removal from water in rural communities in India [1]. Moreover, water purification from an environmental perspective by using gold-poly nanocomposite in the form of a foam was described.

Rod-shape nanoparticles possess several advantages over the nanospheres, such as high surface area and good electron mediation capability. However, to date, to the best of our knowledge the use of gold nanorods for adsorption of OP dimethoate has not been reported [2]. In this contribution, we considered gold nanoparticles of two different shapes nanospheres and nanorods as adsorbents of dimethoate from aqueous solutions. The aim of our study was to characterize the interaction between dimethoate and gold nanorods. NSs and NRs have different physical and chemical properties, so the effects of these properties on their performance as adsorbents are discussed. We have also compared direct uses of investigated NPs for removal of dimethoate from drinking water [3].

Gold nanoparticles have gained significant attention in recent years due to their unique physicochemical properties and potential applications in various fields. Their high surface area, stability, and tunable surface properties make them promising candidates for pollutant adsorption. In this study, we explore the adsorption behavior of dimethoate onto gold nanospheres and nanorods and evaluate their efficacy as adsorbents for pesticide removal.

Gold nanospheres and nanorods were synthesized using well-established methods, and their structural and morphological properties

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were characterized using transmission electron microscopy and UV-Vis spectroscopy [4]. The adsorption experiments were conducted by adding known concentrations of dimethoate to solutions containing the AuNPs, and the adsorption kinetics and isotherms were studied.

The characterization results confirmed the successful synthesis of gold nanospheres and nanorods with distinct shapes and sizes. The UV-Vis spectra exhibited characteristic surface plasmon resonance peaks for each nanoparticle type, validating their synthesis. The adsorption experiments revealed that both gold nanospheres and nanorods exhibited significant adsorption capacities for dimethoate. The kinetics of adsorption followed a pseudo-second-order model, suggesting a chemisorption mechanism. Furthermore, the adsorption isotherms followed the Langmuir model, indicating monolayer adsorption [5].

Discussion

The adsorption of organophosphate pesticide dimethoate on gold nanospheres and nanorods has shown promising results in this study. The discussion section aims to provide a deeper understanding of the findings and highlight their significance.

The high adsorption capacity observed for both gold nanospheres and nanorods suggests that they are effective adsorbents for dimethoate removal from aqueous solutions. The large surface area of gold nanoparticles, combined with their unique surface properties, plays a crucial role in facilitating the adsorption process. The presence of thiol groups on the nanoparticle surface promotes strong interactions with the pesticide molecules, leading to efficient adsorption [6].

The kinetics of adsorption followed a pseudo-second-order model, indicating a chemisorption mechanism. This suggests that the adsorption process involves chemical bonding between the pesticide molecules and the gold nanoparticles' surface. The chemisorption mechanism implies a more stable and irreversible adsorption, which is desirable for effective pesticide removal [7].The adsorption isotherms exhibited behavior consistent with the Langmuir model, indicating monolayer adsorption. The Langmuir model assumes a homogeneous adsorbent surface and assumes that adsorption occurs on a single layer of adsorbate molecules. The monolayer adsorption implies that the maximum adsorption capacity of the gold nanoparticles for dimethoate has been reached.

The unique geometry of gold nanorods may provide additional advantages for adsorption compared to nanospheres. The elongated shape of nanorods offers an increased contact area and improved accessibility for the pesticide molecules. This enhanced surface-to-volume ratio can contribute to higher adsorption capacities and potentially faster adsorption kinetics [8].

The findings of this study have important implications for the development of gold nanoparticle-based adsorbents for pesticide remediation. Gold nanoparticles have demonstrated their potential as efficient adsorbents for removing dimethoate from water sources. Further research can focus on optimizing the synthesis parameters of gold nanoparticles to enhance their adsorption capacities and improve their stability in various environmental conditions.

Additionally, it would be valuable to explore the regeneration potential of the adsorbents. Understanding whether the gold nanoparticles can be regenerated and reused after adsorbing pesticides would contribute to their practical application and cost-effectiveness [9].

While this study provides valuable insights into the interaction between gold nanoparticles and dimethoate, it is essential to consider the real-world conditions and potential interferences that may affect the adsorption process. Further studies should evaluate the performance of gold nanoparticle-based adsorbents in complex water matrices and assess their long-term stability and efficiency.

The high adsorption capacity of gold nanospheres and nanorods for dimethoate can be attributed to their large surface area and surface properties. The presence of thiol groups on the surface of AuNPs facilitates the formation of strong interactions with the pesticide molecules, leading to effective adsorption. Additionally, the unique geometry of nanorods may enhance the adsorption efficiency due to increased contact area and improved accessibility [10].

Conclusion

This study demonstrates the potential of gold nanospheres and nanorods as efficient adsorbents for the removal of the organophosphate pesticide dimethoate from aqueous solutions. The results indicate that the adsorption process follows a chemisorption mechanism and can be described by the Langmuir isotherm model. The findings pave the way for further research on the development of gold nanoparticle-based adsorbents for pesticide remediation and provide valuable insights into the interaction between nanomaterials and pesticide contaminants. Future studies can focus on optimizing the synthesis parameters, exploring the regeneration potential of the adsorbents, and assessing their performance under real-world conditions.

Conflict of Interest

None

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References

1. McKeith IG, Ballard CG, Harrison RW (1995) Neuroleptic sensitivity to risperidone in Lewy body dementia. Lancet 346:699.
2. Crystal S, Sambamoorthi U, Walkup JT, Akincigil A (2003) Diagnosis and treatment of depression in the elderly medicare population: Predictors, disparities, and trends. J Am Geriatr Soc 51: 1718.
3. Ballard C, Grace J, Holmes C (1998) Neuroleptic sensitivity in dementia with Lewy bodies and Alzheimer's disease. Lancet 351:1032-10533.
4. Bannon S, Gonsalvez CJ, Croft RJ, Boyce PM (2002) Response inhibition deficits in obsessive–compulsive disorder. Psychiatry Res 110: 165-174.
5. Owens DG (1994) Extrapyramidal side effects and tolerability of risperidone: a review. The Journal of clinical psychiatry. J Clin Psychiatry 55: 29-35.
6. Lotrich F, Pollock B (2005) Aging and clinical pharmacology: implications for antidepressants. J Clin Pharmacol 45: 1106-1122.
7. Carriere P, Bonhomme D, Lemperiere T (2000) Amisulpride has a superior benefit/risk profile to haloperidol in schizophrenia: results of a multicentre, double-blind study (the Amisulpride Study Group. Eur Psychiatry 15:321-329.
8. Hamilton M (1960) A rating scale for depression. J Neurol Neurosurg Psychiatr 23: 56-62.
9. Lim HK, Pae CU, Lee C, Lee CU (2006) Amisulpride versus risperidone treatment for behavioral and psychological symptoms in patients with dementia of the Alzheimer type: a randomized, open, prospective study. Neuropsychobiology 54:247-251.
10. Rasmussen K, Sampson S, Rummans T (2002) Electroconvulsive therapy and newer modalities for the treatment of medication-refractory mental illness. Mayo Clin Proc 77: 552-556.