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Green Engineering Approaches to Enhance Montmorillonite Clays

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Introduction

Green engineering focuses on making the detoxification process safer, more effective, and environmentally sustainable. Several green modification techniques have been explored to enhance the adsorption efficiency of montmorillonite clays for AFB1 detoxification. The incorporation of natural polymers such as chitosan, cellulose, or plant-based polyphenols into montmorillonite clay can improve its adsorption properties. These polymers have functional groups such as amino and hydroxyl groups, which can form stronger bonds with AFB1. In addition, natural polymers can help stabilize the clay particles, preventing agglomeration and ensuring that the adsorbent remains effective for extended periods. Chitosan, derived from chitin (a natural biopolymer found in the shells of crustaceans), is of particular interest due to its biodegradability and non-toxic nature. When combined with montmorillonite, chitosan enhances the adsorption of AFB1 by improving the clay's surface charge and creating additional sites for interaction with AFB1 molecules. The result is a more efficient detoxification process that is both effective and environmentally friendly [1].

Description

Natural acids, such as citric acid or tannic acid, can be used to functionalize the surface of montmorillonite clays. This modification can alter the surface charge and increase the number of active sites available for AFB1 adsorption. Additionally, these organic acids can enhance the stability of the clay under various environmental conditions, increasing its effectiveness in real-world applications. Citric acid, a naturally occurring organic acid, has been shown to modify montmorillonite by increasing the clay's surface area and improving its ability to adsorb a wide range of contaminants, including aflatoxins. This modification enhances the interaction between the clay and AFB1, resulting in more efficient detoxification [2].

Another green engineering approach involves the use of microorganisms or biological agents to modify montmorillonite clays. Certain bacteria, fungi, or enzymes can be used to increase the adsorption capacity of montmorillonite clays by altering their surface characteristics. These biological agents can be used to synthesize bio-compatible nanomaterials or to induce the formation of bio-inspired structures that improve the clay's affinity for AFB1. For example, mycoremediation, a technique that uses fungi for the bioremediation of toxins, can be combined with montmorillonite clays to enhance their detoxification efficiency. Fungal secretions, which contain various enzymes and organic acids, can modify the surface of montmorillonite, creating a more favorable environment for AFB1 adsorption [3].

Nano-engineering techniques can be applied to montmorillonite clays to further enhance their performance. The creation of nanocomposites by combining montmorillonite with other materials, such as carbon nanotubes or graphene oxide, has been shown to increase the surface area and adsorption capacity of the clay. These hybrid materials can have superior performance in the adsorption of aflatoxins, including AFB1, due to their increased surface area and improved structural stability. The application of green-engineered montmorillonite clays for AFB1 detoxification holds great promise in improving food safety. These clays can be incorporated into food processing and storage systems to reduce the risk of aflatoxin contamination in crops, particularly in regions where fungal contamination is widespread. By adding montmorillonite clays to animal feed or directly to contaminated crops, the adsorption of AFB1 can be significantly reduced, making the food safer for consumption. Montmorillonite clays can also be used as a treatment during food processing. For example, they can be used in the post-harvest treatment of crops like maize, peanuts, and other grains that are commonly contaminated with aflatoxins. Additionally, montmorillonite-based food packaging materials could provide a sustainable means to limit the contamination of packaged foods with AFB1 during storage [4].

The use of green-engineered montmorillonite clays for AFB1 detoxification offers several environmental and health benefits. These clays are non-toxic, biodegradable, and abundant in nature, making them a sustainable solution to the problem of aflatoxin contamination. Unlike chemical detoxification methods, which can introduce harmful residues into the food chain, montmorillonite clays provide a safe, non-toxic alternative. Moreover, the green modification of montmorillonite reduces the environmental impact of traditional detoxification techniques. Green engineering methods are often less energy-intensive and generate fewer pollutants, contributing to a more sustainable food safety system [5].

Conclusion

Green-engineered montmorillonite clays offer a promising and sustainable approach to detoxifying Aflatoxin B1 in contaminated food. By harnessing the natural properties of montmorillonite clays and enhancing their adsorption capacity through green engineering techniques, we can provide a safe, effective, and environmentally friendly solution to the global problem of aflatoxin contamination. As research into green engineering methods continues to evolve, the widespread application of montmorillonite clays in food safety could play a key role in improving public health, particularly in regions that are most vulnerable to aflatoxin exposure.

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Conflict of Interest

There is no conflict of interest by author.

References

1. Oladele, Johnson O., Meichen Wang, Xenophon Xenophontos and Kendall Lilly, et al. "Chlorophyll-amended organoclays for the detoxification of ochratoxin A." Toxins 16 (2024): 479.
2. Simonich, Michael T., Patricia A. Egner, Bill D. Roebuck and Gayle A. Orner, et al. "Natural chlorophyll inhibits aflatoxin B 1-induced multi-organ carcinogenesis in the rat." *Carcinogen* 28 (2007): 1294-1302.
3. Egner, Patricia A., Jin-Bing Wang, Yuan-Rong Zhu and Bao-Chu Zhang, et al."Chlorophyllin intervention reduces aflatoxin–DNA adducts in individuals at high risk for liver cancer." Proc Natl Acad Sci 98 (2001): 14601-14606.

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4. Lee, Jumin, Xi Cheng, Sunhwan Jo and Alexander D. MacKerell, et al. "CHARMM-GUI input generator for NAMD, GROMACS, AMBER, OpenMM, and CHARMM/OpenMM simulations using the CHARMM36 additive force field." *Biophys J* 110 (2016): 641a.

5. Choi, Yeol Kyo, Nathan R. Kern, Seonghan Kim and Krishan Kanhaiya, et al. "CHARMM-GUI nanomaterial modeler for modeling and simulation of nanomaterial systems." *J Chem Theory Comput* 18 (2021): 479-493.

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