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Molecular Detection and Detoxification of Aflatoxins: Recent Advances in Biotechnology and Nanomaterials

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Abstract

Aflatoxins, highly toxic and carcinogenic Aspergillus-produced mycotoxins, represent a global threat to world food safety and public health. Recent biotechnology and nanotechnology advances hold auspicious opportunities for aflatoxin detection and detoxification. Molecular detection techniques, including enzyme-linked immunosorbent assay (ELISA), polymerase chain reaction (PCR), and new biosensors, have dramatically improved aflatoxin detection speed and sensitivity in foodstuffs and feed. These technologies and new nanomaterials, including nanoparticles, carbon nanotubes, and graphene oxide, are fast becoming potent tools for aflatoxin extraction from tainted foodstuffs and agricultural crops. Nanomaterials possess unique features such as high surface area, functionalization, and reusability, which enable more efficient and sustainable detoxification processes. Moreover, nanomaterial-based systems can also be employed in food packaging and storage systems to reduce aflatoxin contamination. In this review, the latest molecular techniques and the potential of nanotechnology in aflatoxin detoxification are highlighted, as well as a general overview of their application in food safety, environmental monitoring, and agricultural sustainability. By examining the unique advantages of nanomaterials, this paper highlights the potential for scalable, cost-effective solutions to prevent aflatoxin contamination at large scales.

Keywords: Aflatoxins, molecular detection, biotechnology, nanomaterials, biosensors, detoxification.